THIRTY-NINTH ANNUAL REPORT OF THE
LOCAL GOVERNMENT BOARD, 1909–10.

SUPPLEMENT

IN CONTINUATION OF THE

REPORT OF THE MEDICAL OFFICER OF THE BOARD

For 1909-10,

CONTAINING A

REPORT

ON

SHELLFISH OTHER THAN OYSTERS IN RELATION TO DISEASE.

By H. TIMBRELL BULSTRODE, M.D.

WITH AN INTRODUCTION BY THE MEDICAL OFFICER OF THE BOARD.

A Report on the Conditions under which certain Shellfish other than Oysters are grown, collected, cleansed and stored, and the relation of such treatment to the prevalence of Enteric Fever and other Illness.

Presented to both Houses of Parliament by Command of His Majesty.

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To the Right Honourable John Burns, M.P., President of the Local Government Board.

Sir,

The report by Dr. Bulstrode, which I have the honour to submit, is in continuation of and supplementary to his report on "Oyster Culture in Relation to Disease," which was submitted to the Board in the year 1894 by the late Sir Richard Thorne Thorne, then Medical Officer of the Board. This earlier report showed that these molluscs were not infrequently collected, fattened or stored under extremely unwholesome and dangerous conditions: and although since the issue of that report material improvement has been brought about in many instances, there still remains, as Dr. Bulstrode observes, "much to be done before the public can consume oysters, bought promiscuously, with a reasonable degree of safety."

Both before and since the issue of that report, annual and special reports of medical officers of health in different parts of the United Kingdom have drawn attention to disease, especially enteric fever, which, with reason, has been ascribed to the eating of oysters and of other shellfish derived from sewage-contaminated layings or beds. This source of infection in recent years has formed the subject of inquiry on the part of a larger number of medical officers of health, and following on this, enteric fever and gastro-enteritis have been more prominently and more frequently attributed, and in large measure traced, to the consumption of shellfish, notwithstanding the fact that the publicity given to this source of disease has been followed by material improvement in many oyster layings. Among instances in which, since the issue of Dr. Bulstrode's first report, disease on a considerable scale has been traced to the consumption of oysters, may be mentioned Dr. Buchanan's report in 1898* on enteric fever in relation to oysters derived from Brightlingsea, and Dr. Bulstrode's report in 1901 on oyster-borne enteric fever at mayoral banquets at Winchester and Southampton.†

In 1908 was issued the report of the Belfast Health Commission, of which Dr. Darra Mair, a Medical Inspector of the Board, was a member. Dr. Mair contributed to this report a searching analysis of the circumstantial evidence which alone was available; and concluded from this evidence that the eating of cockles derived from the Lough was an extremely important factor in the production and maintenance of the very excessive prevalence of enteric fever in that city.

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* Annual Report of Medical Officer of Local Government Board, 1897–98, p. 47.

† Annual Report of Medical Officer of Local Government Board, 1902–3, p. 129.

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Dr. Bulstrode's present report brings up to date and extends our knowledge of the relationship between the consumption of mussels and cockles and the occurrence of disease among those consuming these shellfish. It embodies the results of careful personal inquiries into the sanitary conditions under which mussels and cockles are found in this country.

The distribution of the mussels and cockles around the English littoral is set out in the maps in this report, as is also their relation to the neighbouring sewer outfalls. In interpreting these maps it is necessary to have regard also to the description of the local shellfish industry contained in the letter-press, since the degree of risk to which any given beds are exposed may be dependent upon tidal and other conditions of a complicated nature, which cannot be properly appreciated by a study of the maps alone.

It must also be borne in mind that even if the shellfish beds in a given instance may be relatively remote from sources of pollution, the shellfish gathered from such beds may be temporarily stored in dangerous proximity to sewer outfalls. Of this practice several illustrations will be found in the report.

Validity of Evidence Incriminating Shellfish.

The report raises the important question of the relative value to be attached, in judging the condition of shellfish, of topographical (including tidal), epidemiological, and bacteriological evidence. The records of the past outbreaks of disease reasonably attributed or traced to contaminated molluscs show that these molluscs might properly have been condemned on topographical evidence alone; and a perusal of Part II. of the report shows that many shellfish beds, from which human food is still being derived, are similarly open to condemnation on topographical evidence. Abundant work still remains to be done in the removal of obviously dangerous conditions, or in the alternative course of prohibiting the gathering of shellfish from objectionable places.

Bacteriological evidence of contamination must necessarily, in the present state of bacteriology, occupy a position of secondary importance; though this evidence will serve to put sanitary authorities on their guard. It should, whenever practicable, lead to topographical investigation.

The epidemiological evidence connecting the consumption of molluscs with the subsequent occurrence of enteric fever or gastro-enteritis forms the subject of Chapter VI. of the report. It has been fairly easy to establish the connection between the consumption of sewage-contaminated shellfish and enteric fever when a large number of persons partake of these at the same time and become ill shortly afterwards. But in addition, local investigations made by medical officers of health during the last twenty years have made it probable that shellfish have also caused and are still causing a serious number of sporadic cases of enteric fever which contribute largely to the maintenance of its endemic prevalence. The evidence is not easy to marshal, and it is especially difficult to present it in a form which will be convincing to those who have not had the opportunity of collecting, and in so doing of appreciating the evidence as it gradually accumulates. It mostly consists in a history that the patients have eaten shellfish at some period within the range of the incubation period of the disease. Usually no other source of infection can be discovered, and usually also the shellfish in question have a bad record. But it is likely that others who ate the suspected shellfish at the same time have escaped evil consequences; and then, especially if the incidence of enteric fever among the population who are in the habit of eating shellfish cannot be compared with its incidence among those who do not eat shellfish, the investigator has to be satisfied with a conclusion based on a relatively low degree of probability.

Medical officers of health are, however, justified, in instances in which other more likely sources of infection have been excluded, in drawing attention to the presumptive evidence connecting sporadic cases of dangerous illness with the consumption of a particular food. In many cases the evidence can be strengthened —after sufficient accumulation of instances of accomplished mischief—by showing the greater incidence of enteric fever among those eating shellfish than among the general population. Thus Dr. Johnstone in his report* to the Board on enteric fever in the urban district of Ormesby ascertained that of the patients who had suffered from enteric fever 25·8 per cent. had eaten shellfish from a contaminated source a short time previous to their illness, while among a large sample of the population of Ormesby only 7·3 per cent. had eaten shellfish during the whole of the summer of 1908. In the light of evidence already available, there is reason for believing that much enteric fever, the source of which is still unrecognised, and in particular enteric fever occurring apart from considerable outbreaks, will eventually be traced to the consumption of contaminated shellfish, and that the enteric fever thus introduced at intervals is in a large measure responsible in many districts for the maintenance of endemic prevalence of this disease.

In Chapter X. Dr. Bulstrode has collected and greatly extended the evidence which appears to point to the conclusion that shellfish—at least in certain districts—have material influence in bringing about the excessive prevalence of enteric fever at certain periods of each year.

Difficulties in Administrative Control of Contaminated Shellfish.

Dr. Bulstrode's remarks on pp. 7-8 of the report show the great difficulties in dealing satisfactorily with places where shellfish beds are found in the vicinity of sewer outfalls or where it is proposed to construct a new sewer discharging into an estuary wherein a shellfish industry is situated.

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* Reports on Public Health and Medical Subjects, New Series, No. 17.

During recent years methods of sewage purification have greatly improved, and it has become a prevalent belief that, given an approved method of treatment of sewage, the resulting effluent will be innocuous.

The fact remains, however, that the best effluent known to be discharged into any stream or estuary may still contain the dangerous micro-organisms which are apt to be present in crude sewage. The most that can be said for these methods of treatment of sewage is that the effluent is more sightly than before treatment, and that the number of dangerous micro-organisms has probably been diminished. The pronouncement of the Report of the Royal Commisson on Sewage Disposal* is quite definite.

> With the advance of knowledge it is possible that some method of sewage treatment may be devised by which, within reasonable limits of cost, the dangerous qualities of the sewage may be wholly eliminated, but the treatment of sewage, according to methods at present in use, cannot be relied on so to alter its character as to allow of its discharge in the immediate neighbourhood of shellfish layings, without incurring appreciable risk of disease being communicated by the consumption of shellfish taken from such layings. In such cases either the sewage outfall must be removed or the layings closed.
>
> 35. In other cases where (*e.g.*) the layings are at a considerable distance from the outfall and the sewage would be largely diluted before it reached them, treatment of the sewage might be of value in diminishing risk.
>
> Careful and skilled examination of the local conditions would, however, be necessary to distinguish such cases, and it is not possible by enactment to lay down any general rule as to the cases in which treatment of the sewage should be adopted before the effluent is allowed to flow into tidal waters.

It has furthermore to be remembered that even were a practically sterile effluent secured at anything approaching a reasonable expenditure, it would be necessary to deal also with the water discharged through storm overflows during and after heavy rainfall. Such overflows have up to the present been found to be necessary in all efficient sewerage works constructed upon the "combined" principle, and their presence implies that occasionally large quantities of liquid having the characteristics of sewage, may, in the instances under consideration, be discharged in the vicinity of shellfish beds.

Methods of Control.

The history of the proposals for control of this source of disease (*see* Chapter XII.) is interesting and instructive. Ineffective efforts at legislation have been made; and, failing success, the authorities concerned have fallen back on the publicity secured by local posters and by other methods of advertisement to warn the public against the consumption of contaminated shellfish. This publicity has been far from ineffective as a temporary remedy. A widespread distrust of shellfish has been created, and this distrust has led to a very great reduction in their consumption. With this in some towns has been closely correlated a marked reduction in prevalence of enteric fever. It is an unhappy effect of the employment of this clumsy instrument of reform that the sale of satisfactory as well as of unsatisfactory, shellfish has been greatly reduced; and this is especially unfortunate in view of the fact that, so far as oysters are concerned, many oyster growers have greatly improved the conditions under which their oysters are prepared for market.

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* 4th Report, p. xx (Cd. 1883).

The record, apart from publicity, of failure to control the sale of unsatisfactory shellfish is not, however, unvaried. Reference should be made to the excellent work of the Fishmongers' Company (Chapter XII.); and the Corporation of Blackburn in 1908, in their local Act of that year (pp. 242-243), secured powers similar to those which the Corporation of Brighton unsuccessfully attempted to secure in the year 1896 (Chapter XII.). The chief objection urged against the bestowal of such local powers is that in the event of local powers being granted the shellfish rejected locally will be likely to be sent to other districts, and that, therefore, uniform powers should be granted throughout the country. It was largely on this ground that the powers asked for by Brighton in 1896 were refused. The contention is not altogether sound, for the publicity necessarily attaching to the proceedings which a Corporation take to protect the local population should serve as a warning in other districts of the danger of eating the shellfish against which judgment has been accorded.

An alternative to a local Act was suggested in the report of the Belfast Commission (Chapter XII.). This consists in the local application, as circumstances may require, of the powers conferred by the Public Health (Regulations as to Food) Act, 1907, for " the prevention of danger arising to the public health from the . . . distribution of " shellfish " intended for human consumption."

Regulations could also be made under this Act in respect of imported shellfish, and thus the importation of contaminated shellfish could be controlled.

The recommendations contained in the Fourth Report of the Royal Commission on the Treatment and Disposal of Sewage (Chapter XII.), if adopted, will enable a wider and more systematic local control to be exercised over the methods of sewage disposal and over the sites from which shellfish may be permitted to be derived.

It is unsatisfactory to have to record that at the present time, notwithstanding the occurrence of intermittent " scares " (which imply major outbreaks of disease due to shellfish), and in spite of the persistent efforts made in some districts to warn the public against the danger of consuming uncooked shellfish, no legal provisions for preventing the collection from, or the laying down or cleansing of shellfish in, obviously polluted places have hitherto become generally available.

Part II. of Dr. Bulstrode's report brings out in unmistakable fashion the dangerous conditions and practices which still obtain at some of the most important centres in which shellfish are grown.

I am, Sir,
Your obedient Servant,
ARTHUR NEWSHOLME.

February, 1911.

PART I.

CHAPTER I.

Scope of the Inquiry and some Preliminary Considerations.

The primary object of this investigation was to ascertain whether there is need for some control over the collection, cultivation, and cleansing of certain shellfish which are eaten either raw or imperfectly cooked and which have been shown by evidence of a circumstantial nature to have been, at times, instrumental in producing outbreaks of enteric fever and of gastro-enteritis.

The shellfish more particularly concerned in promoting such outbreaks are oysters, mussels, and cockles.

As regards oysters it was shown by the author's report to the Local Government Board in 1896* that there was urgent need for reform in the matter of "fattening" and storage of these molluscs, and, at certain places, the pollution to which the oysters were exposed was gross, obvious, and indisputable. It is instructive to note that in connection with oysters procured from places obviously exposed to pollution there have been subsequently well-marked outbreaks of enteric fever and other illness directly attributable to the oysters in question.

Material improvement has taken place at some of the worst places in the conditions under which oysters are prepared for markets. This is due in part to the outbreaks of enteric fever which occurred before and since the issue of that report, and to the attention drawn to the subject by reports made by medical officers of health. But, notwithstanding such improvement, much still remains to be done before the public can consume oysters, bought promiscuously, with a reasonable degree of safety.

With regard to mussels and cockles, the shellfish mainly dealt with in the present volume, very little has yet been accomplished and, as has been said, one object of this report is to bring out the conditions under which these molluscs are at times collected and cleansed. It has not been practicable in connection with the shellfish here dealt with to carry out such a detailed survey as was the case with oysters, which are confined to very definite localities and concerning which well defined cultural and fattening processes are undertaken. In other words the distribution of mussels and cockles around the English and Welsh littoral is far more general and much less defined than is the case with oysters; indeed there are relatively few places around the coast at which either mussels or cockles may not be discovered by careful search. But it has, nevertheless, been found possible, with the assistance afforded by the officers of the several

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* Twenty-fourth Annual Report of the Local Government Board, 1894–95. Supplement in continuation of the Report of the Medical Officer for 1894–95 on Oyster Culture in relation to Disease. Eyre and Spottiswoode. 1896. (C. 8214). Price 8*s*. 6*d*.

Sea Fisheries Districts and with the aid of the numerous sanitary authorities involved, to ascertain the chief centres in this country, and to visit a very large proportion of those from which the shellfish, with which this report is chiefly concerned, are despatched to market. But, as will be seen later, large quantities of shellfish of practically all varieties are introduced into England and Wales from foreign countries and from other parts of the British Isles, and these sources of supply are outside the scope of this inquiry. Incidentally, however, evidence has been adduced demonstrating the need for control over these outside sources.

Mussels and cockles are found very largely at or near the mouths of estuaries, a fact which renders them liable to be affected by the pollutions which are not uncommonly brought down by the waters of such estuaries.

This distribution of shellfish in these localities opens up some very large questions as regards risks of contamination and it really necessitates, if the matter is to be gone into with minuteness, a survey of the rivers which enter the estuary from their rise to their confluence with such estuary, as well as a minute examination of the estuary itself. But a work of this nature involving, as it would have done, the survey in detail of a very large number of catchment areas is clearly beyond the scope of one individual within a limited time and it was, therefore, determined to pay chief regard to what may be termed proximate sources of pollution, that is to say, the presence of sewers in the vicinity of the shellfish beds.

Fortunately, the history of past outbreaks of enteric fever and gastro-enteritis which have been associated with the consumption of shellfish has shown that the shellfish in question have been collected from localities and beds which were obviously liable to pollution and although, having regard to the history of water-borne epidemics of enteric fever and cholera, it cannot be affirmed that distant sources of pollution may not at times be operative for harm it is quite clear that, were all the proximate sources of pollution removed, there would be a very material decrease in the number of cases of enteric fever which are now attributable to shellfish.

It is for much the same reason that it has been decided not to include bacteriological examination of water, mud, and shellfish in this investigation.

It was found during the inquiry relative to oysters that bacteriological investigation yielded somewhat conflicting results, and it cannot be said that at present bacteriologists are in agreement as to the standard to be adopted, and this seems to be the case whether regard be had to the total number of organisms present, the percentage proportion of certain organisms or to the mere presence of certain organisms. It has also to be added that there are as yet no tests which will serve to differentiate sewage micro-organisms of human origin from those of animal origin and, even if it were practicable or desirable to distinguish between the two, it would be difficult to fix reliable standards when dealing with estuarial waters draining a whole catchment area much of which might be devoted to grazing purposes. But had time allowed much valuable information might have been gathered from repeated bacteriological examination of each shellfish bed. It was clear, however, that unless samples could be taken at almost all possible combinations of tide and wind, and of flood and drought, shellfish beds might have been given a clean bill of health from a bacteriological standpoint and yet be obviously liable to pollution under certain conditions, and thus a fallacious guarantee of safety might have been afforded.

For instance, it would be practicable to procure a sample of water from over a shellfish bed at a time when the outlet of a drain or sewer discharging quite near to, or even over, such bed was closed by the head of several feet of water in the estuary and when no hand-picking of the shellfish could possibly take place. Such a sample might yield both chemically and bacteriologically excellent results and yet convey to the public a very misleading impression of the condition, *quâ* purity, of the shellfish below. Similarly, samples of shellfish themselves might be dredged up at such a time and also yield good results. Clearly, the only satisfactory sample would be one taken at a period when the sewers were discharging and when the shellfish were habitually collected. Again, it would be misleading to take a sample of water from near to a sewer outfall and infer from it the risk to shellfish if the volume of water and the tidal currents were such that no sewage from such outfall could reach the shellfish bed other than, if at all, in a condition of enormous and possibly negligible dilution. Conditions such as these are not rare. Suppose, for example, a shellfish bed to be situated high up on the banks of a wide and deep estuary into the narrow low-water channel of which there discharges a sewer covered with a tidal flap closed, say, on the rising tide at near half-flood, after which no sewage can escape therefrom until half-ebb. Consequently, on the flood no sewage from this outfall could possibly reach the shellfish bed here under discussion, while on the ebb the bed might be entirely uncovered by the tide before any of the enormously dilute sewage which had been carried high up the estuary during the latter half of the flood could return to reach such shellfish bed. This example is merely furnished as an illustration of the misleading inference either in the direction of purity or impurity which might be drawn from a single sample and which might be made to serve either as a certificate of purity or impurity for a long period.

It is necessary, too, to point out that the standards adopted by some bacteriologists would not improbably serve to condemn every shellfish bed around the littoral. Possibly the time may come when a standard of this nature may be regarded as desirable but, in the meantime, a useful provisional standard is one based upon topographical and epidemiological grounds.

No pretence is made that a standard thus based is satisfactory or final, but it is one which, if intelligently acted upon, should lead to very great improvement in the conditions under which shellfish are now gathered and which may not improbably save from greater disaster an important industry.

It was, too, the standard mainly adopted in the report upon oyster culture and had the worst conditions revealed in that report been remedied the outbreaks and prevalence of enteric fever which subsequently occurred might have been prevented.

With regard to the topographical aspect of the question it has to be borne in mind that the course of the channels and the positions of the sandbanks are prone to change, especially in some estuaries, and in consequence of these changes shellfish which are now exposed to pollution may be in the not far distant future remote therefrom, and the reverse. Moreover, the positions of the cockle beds themselves tend in the course of years to change, and a map showing their distribution in an estuary at one time may not correctly represent the state of affairs in years to come, and the same statement, although in a minor degree, is true of mussels.

With the object of indicating the relations between the shellfish beds and the sewers in their vicinity maps, for the most part on a scale of an inch to the mile, which serve to show in a general way the relations between the two have been constructed; but in estimating the value of these maps it must always be borne in mind that the crosses indicating the position of the sewer outfalls are, relatively to the scale of the maps, much too large.

Moreover, a red cross may in one case indicate a sewer from 2 or 3 houses, and in another, that draining a large population.

Consequently the maps alone, although generally very instructive, may, without regard to the descriptive matter which accompanies them, be distinctly misleading.

On the other hand it would be impossible without the maps to appreciate the actual relations of the shellfish beds and the sewers.

It has to be observed that the precise measure of danger to which the shellfish in any given case may be exposed can only be gauged by consideration of several factors, such for instance, as the relative volumes of the sewage and of the water with which it becomes mixed, the time of liberation of the sewage, and the "set" of the tidal currents.

It might, for example, be practicable, where an outfall is near to the mouth of an estuary, to store up and liberate the sewage on the ebb so that none of it can return to the estuary on the flowing tide.

In other cases, however, the position of the outfall in an estuary may be such that it is impracticable to discharge the sewage so that all of it can escape from the estuary on the ebb of one tide and, as a result, the incoming flood must carry up some of the sewage above the outfall, and this process constantly repeated gives rise in the estuary to what is known as a "sewage zone" such zone oscillating up and down the estuary with each flow and ebb of the tide, sewage being only carried out to sea very gradually through the influence of the fresh water running down from the uplands which, by degrees, displaces portions of the sewage zone beyond the confines of the estuary.

Difficulties as regards the control and purification of sewage.

It is desirable briefly to discuss this question here, because it has not yet been adequately appreciated by those who have had to deal with the problems of shellfish pollution either in its scientific, practical, or legal aspects.

In the construction of a sewerage system it is the usual custom where a combined system to take both sewage and rain-water is in question to construct the sewers of such a size and gradient as will enable the dry weather flow to pass to the outlet at such a velocity and in such a fashion as to prevent deposit of sewage in the sewer. This provision generally renders it necessary to construct the sewers of such a size that they are not capable of dealing with excessive downfalls of rain and hence what are known as " storm-overflows " have to be introduced.

These overflows come into operation when the dry weather flow has been diluted perhaps six times, or more, and the overflows discharge, as a rule, into the same river or estuary as the purified effluent.

Now it has been shown by the Royal Commission on Sewage Disposal that notwithstanding its great dilution the liquid escaping from these storm overflows is at times exceedingly foul, and that bacteriologically it may differ little from crude sewage.

Moreover, it is not unusual in times of heavy storm to see entirely crude sewage escaping from these storm overflows, and it is, therefore, clear that so long as these overflows are thus liable to discharge a highly impure liquid there is risk of contamination from these sources notwithstanding the purification of the sewage at the outfall.

But there is, too, a further question which has to be considered, and it is this. During times of heavy storm the sewage purification works are usually incapable of dealing adequately with the whole volume of sewage which comes down and in consequence that beyond a certain excess has to be discharged either after no treatment at all or after passage through what are known as " storm-water tanks "; or it is passed at an accelerated rate through the filters. It is of course true that much of the storm water thus dealt with is enormously diluted sewage, but the fact that bacteriologically it is crowded with organisms, such as *bacillus coli communis* and *bacillus enteritidis sporogenes*, which might lead to the condemnation of shellfish over which it flows, is a very important administrative consideration.*

Unfortunately, however, the difficulties connected with sewage purification have not yet been exhausted and the important additional statement has to be made that at present there is no practicable method of sewage treatment apart from sterilisation which will afford guarantee against the presence of organisms of intestinal origin in the effluent. With the discovery of " septic tank " treatment it was hoped that a method for the destruction of pathogenic organisms had been secured, but recent work has shown that neither the septic tank alone nor in combination with

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* Fifth Report of the Royal Commission on the Treatment and Disposal of Sewage. Appendix V. Wyman & Sons, London, 1908. [Cd. 4283.] (Report by Mr. B. Latham and Mr. R. A. Tatton.)

"bacterial" filter beds will suffice to remove the sewage organisms; and in dealing with the shellfish problem this is one of the difficulties which have to be faced.

Shipping as a Vicarious Source of Shellfish Contamination.

Although opportunity for contamination from this source may not, in relation to the whole shellfish industry, be of at all frequent occurrence, it cannot be overlooked, more especially so as it is a source which it is extremely difficult to control.

Obviously shipping as a possible polluting factor is most likely to be mainly a source of anxiety in estuaries such as the Thames and the Mersey, which large liners, carrying sometimes many hundreds of passengers and crew, are accustomed to traverse, or in estuaries like the Medway and harbours such as Portsmouth, where large vessels, each carrying population of village or small town dimensions, are to be found at anchor.

But the same source of pollution is by no means negligible in smaller places, where the shipping consists of a few steamers and some coasting craft, or even in centres where there is a considerable fishing fleet.

It is clear that in places such as those where perhaps extensive sewage purification schemes have been undertaken that vicarious pollution by shipping may not improbably lead to condemnation bacteriologically of shellfish or water or to the involvement of such shellfish in an epidemiological sense.

CHAPTER II.

The Mussel and Cockle Beds on the English and Welsh Littoral.

It is proposed now to give an outline sketch indicating the chief centres of the mussel and cockle industry in England and Wales by making, as it were, an imaginary journey around the coast starting from Berwick-upon-Tweed on the east and terminating at Solway Firth on the west, and to facilitate this imaginary journey a map is furnished showing by blue circles the mussel sources and by green circles the cockle sources.

The Mussel Beds.

At Berwick-upon-Tweed the mussels are utilised mainly for bait by the long-line fishermen and the same observation applies to the mussel beds along the whole of the Northumberland coast.

But the Northumberland beds do not, other than in quite exceptional years, suffice for the needs of the fishermen and, consequently, large quantities for use as bait are imported from Morecambe Bay and the Welsh coast as well as, at times, from Ireland.

At Holy Island and in Budle Bay attempts at mussel culture have been, and are being, made, and a limited supply of mussels is found at places such as Alnmouth, Amble, Blyth, and Tynemouth.

A small quantity of mussels consumed for the most part in Sunderland is found in the River Wear; but, apart from this, the coast of Durham furnishes little or nothing until the mouth of the Tees is reached and here mussels are collected in some quantities both for bait and human food. Formerly this locality supplied bait to many fishing centres along the East coast of England as well as to some places in Scotland, but the mussels, although a considerable sum of money has been spent upon their cultivation and control by the North Eastern Sea Fisheries Committee, have apparently deteriorated and at the same time shellfish other than mussels are being used in increasing degree by the fishermen for bait. There is no mussel fishery of note on the Yorkshire littoral after going south from the estuary of the Tees, but in the Humber,* formerly an important centre of supply, there are still some collected both for bait and human food.

Along the Lincolnshire coast there is no trade in mussels until we arrive at the Wash, which arm of the sea is one of the most important shellfish areas in the whole country. Very large amounts of mussels are collected over the "scalps" hereabouts and are despatched by train from Boston and Lynn to all parts of the country even as far as the south coast of Wales, while large quantities of young mussels—mussel "brood"—are transferred from the "scalps" in the Wash to the numerous creeks and harbours of places such as Brancaster, Overy Staithe, Wells, and Blakeney, on the north coast of Norfolk, at all of which a large number of fishermen obtain a livelihood by mussel culture.

At Great Yarmouth there are mussels in the Yare and there are also some gathered in Breydon Water at Lowestoft. Mussels are collected off Harwich and at the mouth of the Thames from Maplin Sands, off Southend and Leigh.

Along the Kentish Flats off the north coast of Kent large supplies are in some years dredged up and there are, in addition, sundry inshore beds along this same coast from Whitstable to eastward of the Reculvers.

Along the south coast of Sussex the mussel beds are few, but in the Ouse at Newhaven and at Shoreham, westward of Brighton, these molluscs are collected both for food and bait near the Suspension Bridge in the River Adur.

Further westwards, Chichester harbour in Sussex and Langstone and Portsmouth harbours in Hampshire yield supplies and there are some to be found in and about Southampton Water. But apart from these places there is very little trade done along the south coast until the Devonshire rivers are encountered.

Hereabouts, extensive supplies are found in the estuaries of the Exe and the Teign as well as in some degree in the Dart, the Salcombe River, and the Yealm. A few are collected in the River Tamar at Plymouth.

In Cornwall the only source of supply known to the Fishery Officer of the Cornwall Sea Fisheries District is Newquay on the north coast.

In the estuary of the Taw in North Devon mussels are collected and despatched to Bristol, London, and Manchester, but, according to my information, there are no beds of importance in the

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* Report on the Mussel and Cockle Beds in the Estuaries of the Tees, the Esk, and the Humber, by Professor McIntosh, M.D., LL.D., F.R.S., &c., 1891.

Bristol Channel until the south coast of Glamorganshire where mussels are found at certain places in Swansea Bay, to the south of Mumbles Head, off Pwll-du-Head and Oxwich Point as well as to the South of Worms Head.

In Burry Inlet between Carmarthen and the Gower Peninsula of Glamorganshire there are mussel beds off Llanelly, Burry Port, and Whiteford Point, as well as in the mouth of the Towy River (Carmarthen) off Llansaint.

Around the coast of Pembrokeshire there are, the Fishery Officer of the Milford Haven Sea Fisheries District states, no mussel beds, and the west coast of Wales yields nothing of much value south of the Dovey River, which is an important source of supply to certain large towns.

In addition to this estuary there are along the Merionethshire coast the Barmouth estuary as well as that of Portmadoc, and both of them furnish supplies to English towns of first class magnitude.

Along the Carnarvonshire coast a few mussels are obtained from Pwllheli, from opposite Carnarvon, and from near Bangor, but by far the most important centre along the north coast of Wales is at Conway, where the estuary forms one of the most fertile sources of mussel supply in the country as a whole.

Eastward of this there are a few mussels collected in some seasons at Rhyl, but the next area of any magnitude is the estuary of the Dee, from several parts of which abundant supplies are obtained.

In and at the mouth of the Mersey there are some beds of relatively small importance.

At the mouth of the Ribble, on the Lancashire coast, there are mussel beds off Lytham and also one just north of St. Anne's pier, while in the River Wyre, at Fleetwood, there are beds both in the river itself and at its mouth.

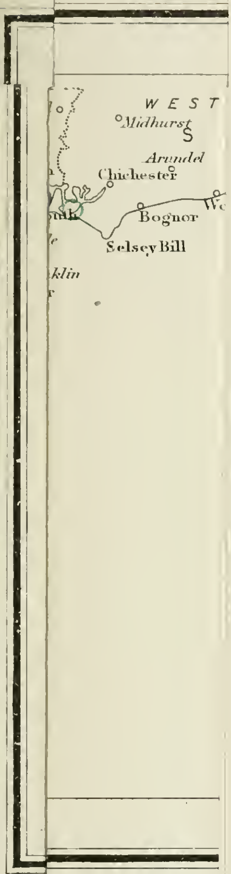
There are mussel beds in the estuary of the Lune, and further north along the littoral the very important beds off Morecambe are found. These take rank from the point of view of size amongst the most important in the British Isles.

On the opposite side of Morecambe Bay there are beds of less value off Roosebeck, Piel Island, and Walney Island.

Northward of this again supplies are found in the Duddon estuary, but the coast of Cumberland beyond these sands yields nothing beyond a small supply from Ravenglass. To the north of Ravenglass some mussels are landed at Workington and sold locally, but these are taken from a mussel "scalp" on the Scotch side of the Solway Firth, and are therefore beyond the scope of this report.

The Cockle Beds.

Dealing with cockles in the same fashion as with mussels and starting from Berwick-upon-Tweed in a southerly direction, it is found that the Northumberland coast yields very small supplies, and these are mainly from the Fenham Flats between Holy Island and the mainland and from Budle Bay.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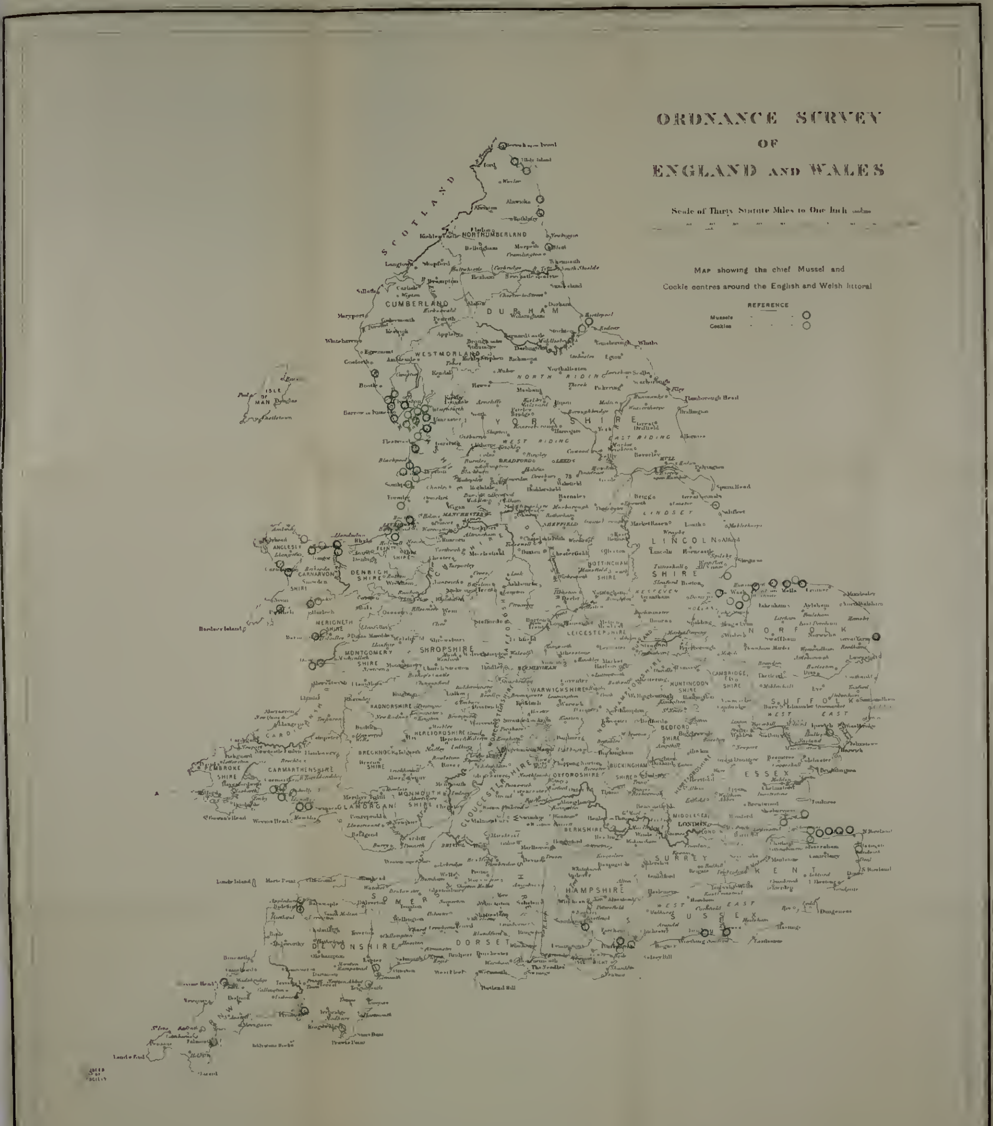
MAP No. 1.


ORDNANCE SURVEY
OF
ENGLAND AND WALES
Scale of Thirty Statute Miles to One Inch
Map showing the chief Mussel and
Cockle centres around the English and Welsh littoral
REFERENCE
Mussels ○
Cockles ○
SCOTLAND
NORTHUMBERLAND
CUMBERLAND
DURHAM
WESTMORLAND
ISLE OF MAN
YORKSHIRE
NORTH RIDING
WEST RIDING
EAST RIDING
LINCOLN SHIRE
LINDSEY
KESTEVEN
NOTTINGHAM SHIRE
ANGLESEY
CARNARVON SHIRE
DENBIGH SHIRE
MERIONETH SHIRE
MONTGOMERY SHIRE
SHROPSHIRE
LEICESTERSHIRE
NORFOLK
CAMBRIDGE SHIRE
HUNTINGDON SHIRE
SUFFOLK
WARWICKSHIRE
RADNORSHIRE
HEREFORDSHIRE
BRECKNOCK SHIRE
CARMARTHENSHIRE
PEMBROKE SHIRE
GLAMORGAN SHIRE
MONMOUTH SHIRE
GLOUCESTERSHIRE
OXFORDSHIRE
BUCKINGHAM SHIRE
BEDFORD SHIRE
HERTFORDSHIRE
ESSEX
MIDDLESEX
LONDON
BERKSHIRE
SURREY
KENT
HAMPSHIRE
SUSSEX
SOMERSET
DEVONSHIRE
DORSET
CORNWALL
ISLE OF WIGHT
MANCHESTER
SHEFFIELD
LEEDS
BRADFORD
HULL
BIRMINGHAM
BRISTOL
Lundy Island
Lands End
Bardsey Island
Flamborough Head
Spurn Head
Portland Bill
Dungeness
Holy Island

Along the coast of Durham the only cockle area of any importance is over the Seal Sand at the mouth of the Tees, while Yorkshire furnishes no extensive supply of these molluscs along the whole of its rocky shore.

In Lincolnshire there are cockle beds near the mouth of the Humber, between Tetney Haven and Donna Nook, while further southwards in the Wash are some of the most valuable beds in the country, the cockles from the Lincolnshire side of the Wash being despatched chiefly from Boston.

In Norfolk, Lynn acts as the chief centre of distribution from that side of the Wash, while several small places along the northern coast of the county, such as Snettisham, Heacham, and Stiffkey, furnish small supplies.

In Suffolk cockles are collected in the estuary of the Orwell mainly, it is alleged, for local consumption, while from the Maplin Sands, off Essex, and from other sandbanks on the north side of the Thames estuary come large quantities, which reach the London market, viâ Leigh-on-Sea, and which are consumed also at Southend and other places by excursionists.

On the north coast of Kent there are cockles on the sandy foreshores of the Isle of Sheppey, on the Whitstable Flats and in smaller degree at other places between Whitstable and Westgate, while on the east coast of Kent there are extensive areas in Pegwell Bay, near Ramsgate, from which cockles are collected. Along the south coast of Kent these molluscs are rare, but in Sussex they are found in Chichester Harbour, and, in Hampshire, in Langstone and Portsmouth Harbours, at all of which places there is some trade in them.

A few cockles are met with at places on the Dorsetshire coast, but it is not until Devonshire is reached and the Exe entered that any considerable quantity is found. In the Teign there is a local trade of some significance, and small amounts are collected in the Dart and in the Salcombe estuary as well as in the Avon, the Erme, the Yealm, the Plym, and the Tavy.

There are, I am informed, practically no cockles in Cornwall, but there is some trade done in the Taw and Torridge in North Devon.

From South Wales extensive supplies are obtained from Burry Inlet and the southern coast of Carmarthenshire, the cockles being despatched from Penclawdd, Ferryside, Langland, and St. Clears stations.

The coast of Pembrokeshire, which is for the most part rocky, supports practically no cockle industry, nor are these molluscs found in any amount until the River Dovey, in Merionethshire. Supplies are despatched from here as well as from Barmouth and Portmadoc, from certain places on the Anglesey coast, and from Aber and Llanfairfechan, on the north coast of Wales.

In the estuary of the Dee there are extensive cockle beds, and at intervals up the whole of the Lancashire coast large quantities are collected.

Off Formby, in the mouth of the Ribble, in the estuary of the Lune, over practically the whole of Morecambe Bay, and as far north as the Duddon Sands are beds of very considerable commercial importance, and from the little station of Cartmell there are daily despatched enormous quantities of these shellfish to the northern and midland towns.

North of the Duddon Sands very few cockles are found to the south of the Scotch border.

CHAPTER III.

The Collection and Cleansing of Mussels and Cockles and the degree of control which is at present exercised over the manipulation of these shellfish.

Mussels.

The method of collection of these molluscs varies materially according as to whether the "scalps" or "beds" ebb dry or not, and as some "scalps," usually covered, may be uncovered at low water of certain spring tides, it is clear that even in relation to the same "scalp" the practice differs from time to time.

When the mussels ebb dry the usual practice is to collect them by handpicking, the mussels being gathered in the first instance into a small hand net. When this net is full it, with its contents, is usually washed in the adjoining water, and the mussels are then either emptied loose into a boat or transferred directly to the bag in which they are to be despatched to market.

In places where the mussels are always covered with water as is the case, for instance, very largely at important centres of the mussel industry such as Morecambe, Conway, Aberdovey, Barmouth, and the River Teign, it is the custom to use either a dredge similar to that employed in dredging for oysters, or, more usually, a long teethed rake attached to a handle of the length necessary to reach the bottom of any given river or estuary. The handles of these rakes are sometimes of great length, some I have measured reaching a length of 50 feet.

The head of the rake is furnished behind with a net which is attached partly to the back of the rake proper and partly to the handle, the object of the net being to prevent the mussels from falling over the back of the rake into the water when the rake is being drawn up.

The use of these long rakes requires, as the writer has himself experienced, considerable strength and skill.

The dredgeman standing in his boat throws the rake—by allowing the handle to slip through his hands—up stream, *i.e.*, against the tide, and he then lets the head of the rake sink to the bottom. The handle of the rake is then pressed down over the right shoulder by the use of both hands and arms in such a fashion as to work the teeth along the ground, the effect of this process being partly to draw the boat up stream and partly to drag the rake down stream until the handle is practically vertical when it is raised by the hands until the head of the rake is at the boat level, when by a dexterous twist of the wrist the mussels are emptied from the teeth of the rake into the net above referred to and then into the boat. This process is repeated until the tide begins to "make" or a sufficient quantity of mussels have been collected.

The boat is then taken back to the harbour where the mussels are picked over, the small ones and the stones being rejected and the marketable mussels packed in bags of from 1 to 1¼ cwt. for despatch to the wholesale dealer by train.

The Cleansing of the Mussels.

Mussels when collected have very generally attached to them a quantity of debris consisting of stones, small mussels, seaweeds, and other materials, and they also bear at times when collected from muddy foreshores a considerable amount of mud. Both the debris and the mud have to be removed before the mussels are sent to market, and after the mussels have been picked over to separate the debris it is usual to wash them in any water which may be convenient at the moment. Sometimes the mussels are washed on the beds or "scalps," but not infrequently the whole boatload is brought back to harbour and there washed and packed.

This practice of bringing the mussels back to the harbour or town to wash and pack is, at times, a disastrous one for the purity of the mussels, since mussels collected from localities where they are little, if at all exposed to the risk of specific contamination are brought back and, in not a few instances, washed in close proximity to sewer outfalls. It would seem indeed as if some of the mussel gatherers had supreme contempt for the sewage of towns since they may be seen over and over again either raking for, handpicking, or washing mussels actually at the very mouths of sewers or drains.

The control at present exercised over the Collection and Washing of Mussels.

At the present time such control as is exercised over the collection of mussels has relation solely to the commercial aspects of these shellfish, and it is exercised through the medium of byelaws made and enforced by the several Sea Fisheries Committees.

These bye-laws relate, in the first place, to the size at which mussels are allowed to be collected, the usual minimum length being 2 to 2¼ inches, and they also have reference in some measure to the actual method of collection. By such bye-laws a close season is sometimes enacted during which no mussels may be collected. The close season most commonly imposed being the months of May to August inclusive. In some cases, however, the close season is longer than this. Byelaws may also be imposed for the relaying of young mussels raked up or picked in this process of collecting marketable mussels, and for the closure of certain portions of some shellfish areas for stated periods. Byelaws providing for all the points mentioned above are in force in the Lancashire and Western Sea Fisheries District and to some extent also in the Eastern District, but in the majority of the other districts there are no byelaws relative to mussels in operation. But the important point to note is that at the present time there are no restrictions prohibiting either the collection of mussels from the vicinity of sewer outfalls or the deposition of such shellfish either for storage or growth in similar positions. Moreover there is nothing to prevent the mussels from being washed actually at the mouths of sewers, and a perusal of the body of this report will serve to show that all these practices not infrequently obtain.

Cockles.

It is over the large expanses of sand which are exposed at certain places on the English and Welsh littoral that cockles are collected. The cockles are situated about half-an-inch below the surface of the sand and their whereabouts may sometimes be detected by the little tufts of Algæ which protrude from the holes made by the inhalent and exhalent syphons of the mollusc.

It is the object of the cockle gatherer to arrive on the cockle-bearing sands as soon after the tide has left them as practicable, and the position of the sands renders it necessary that sometimes they shall be approached on foot, perhaps with a cart or donkey to carry back the shellfish collected, or with a boat; but in any case the method of collection is identical.

The cockle gatherers armed with a hook, a small rake, or a hoe, rapidly scrape the surface of the sand, the cockles beneath the surface being at once revealed either by sight or touch. The cockles are rapidly transferred to the basket or bag carried by the cockle-gatherers, and when this is full they are washed in one of the rivulets traversing the sands or in natural or artificial pools of water. The cockles are then emptied into the cart or boat in a loose condition or transferred direct to a sack or bag for convenience of carriage. At some places, such for instance as Penclawdd, on the coast of the Gower peninsula in South Wales, the sacks of cockles are borne by donkeys across the sands to the village or carried on the heads of the cockle-wives.

The byelaws in force in respect to cockles in certain of the Fishery Districts do not prescribe a close time for cockles, but they relate to the size of such shellfish and to the instruments with which they may be collected.

In the Lancashire and Western Sea Fisheries District the cockle gauge carried by the Fishery Officers is two inches in length and three-quarters of an inch in breadth, and, as Mr. Johnston observes in his valuable memoir on the anatomy of the cockle, "the smallest legal-sized cockle may be defined as a cockle whose lateral breadth from valve to valve when the shell is closed is just over three-quarters of an inch," and it represents in his opinion the size of the mollusc which is over two and less than three years old. Regulations as to the instruments with which the cockles may be gathered relate in the main to the size of the rake and the interval between its teeth, but in the

Lancashire and Western Sea Fisheries District there is allowed to be used in some places and at certain seasons an instrument known as a "Jumbo," the object of which is to enable pressure to be applied to the sand in a more methodical fashion than is possible by treading or stamping upon the sand with the feet shod in heavy boots, and by this means the cockles are, as it were, expelled or driven out from the sand on to the surface from which they can be easily gathered.

The "Jumbo" consists of a wooden frame, the base of which must not be more than 4½ feet long, 14 inches wide, and 1 inch in thickness. By rocking the frame backwards and forwards the base forces the cockles out of the sand and they can then be rapidly collected. The "Jumbo" may only be used from November to February, both inclusive.

Another instrument used in this same district is the "craam," which is a metal three-pronged fork, the prongs of which are some six inches in length, the distal two inches being bent down at right angles. This fork is fixed into a handle some 18 inches long, and by an agile stroke with the right hand the expert cockler is able to scoop the cockles out of the sand into the basket, which he pushes along the sand with his left hand.

In other parts of this district the use of the spade is permitted, the upper layer of sand to a depth of about 1½ inches being removed.

The rake is also very commonly used, and this may not exceed 12 inches in length.

Although cockles are very generally washed on or near the beds from which they are collected, there are some very important exceptions to this practice, and in some of our largest centres of the cockle industry the practice obtains of washing the collected cockles in estuarial water, which is obviously unclean, and which is in some cases exposed in high degree to pollution by sewage.

Conditions in which the Cockles are Despatched to Market.

The precise condition in which cockles are sent for immediate consumption varies in different parts of the country.

In the north of England, *i.e.*, on the Lancashire, Northumberland, and Cheshire coasts, the cockles are almost invariably sent away in their shells, an arrangement which means that the cost of carriage is considerable.

On the south coast of Wales, however, as well as at some places on the east coast of England, such as Boston, Lynn, and Leigh-on-Sea at the mouth of the Thames, large quantities of cockles are despatched in the soft state, *i.e.*, the shells are separated from the soft parts and, where this practice obtains, the process is usually as follows. The cockles brought from the sands in their shells are boiled—either in a large cauldron, as at Penclawdd, or in specially constructed "coppers" as at Boston, Lynn, and other places. At Leigh-on-Sea, owing to the conveyance of enteric fever by consumption of cockles polluted by being laid down in Leigh Creek or procured from polluted sources, the cockle merchants have each provided themselves with a form of autoclave or steriliser, which consists of an iron case or box provided with trays. The live cockles are placed on these trays, the clamps of the autoclave closed and steam under pressure turned on. After five minutes exposure to the steam, as measured by an hour glass, the cockles are taken out and riddled, the soft parts passing through the intervals in the sieve the shells remaining behind.

Where "coppers" are used, the practice is to place the cockles, while still in the small nets, into a large net or bag, which by the aid of pulleys is lowered into the copper containing water, which may be at the moment of immersion either actually boiling or nearly so. The immersion of the cold cockles lowers the temperature and the water has again to be brought to the boiling point. I have observed, watch in hand, this process of cockle boiling at different places around the coast, and the conclusion at which I have arrived is that although the cockles at or near the bottom of the "copper" or cauldron are as a rule sterilised those which are at or near the top often escape with a steaming which is sufficient to induce them to open their shells but which does not suffice to destroy all the organisms which may be present. When the upper cockles open, owing to the passage of steam from below, the whole mass is lifted out, and in this way cockles near the surface sometimes escape sterilisation.

The soft parts of the cockles are, after the riddling process, repeatedly washed in water and finally they are liberally salted, wrapped in butter muslin, and despatched to market in baskets.

It will be seen by the above description that these boiled or sterilised cockles are afforded opportunity of becoming polluted by the water in which they are washed after being boiled, and it is believed that in at least one notable instance specific contamination of cockles was thus caused.

Sometimes, too, cockles collected from sources remote from pollution are laid down to clean themselves of sand in creeks or positions where they may become specifically contaminated, and a point such as this is worth remembering when cockle-born outbreaks of enteric fever or other illness are under investigation.

The Number of Persons engaged in the Mussel and Cockle Industries.

There is very considerable difficulty in arriving at even an approximate estimate of the number of persons engaged in these industries, but through the kindness of the Lancashire and Western Sea Fisheries Committee, data have been obtained from every division in that district. Forms were sent to the several Fishery Officers with a request that they should be filled up as accurately as possible. Although it is probable that persons engaged in mussel gathering not infrequently resort to the cockle grounds or *vice versâ*, the figures suffice to show what a large number of families are at times concerned in some degree in one or another of these industries.

If, of course, those engaged in the oyster, whelk, or periwinkle industry be added the numbers would show a very material increase, especially in counties, such as Kent and Essex, in both of which a very large trade in oysters is carried on.

District.		Men, Women, and Children employed.			Mussel Boats.	Cockle Carts.	Families wholly or partially dependent on shellfish.
		Whole Season.		Occasionally.			
		Mussels.	Cockles.	—			
Capt. Wright	1. Cark Kents Bank Grange, &c.	—	110	—	—	36	50
	2. Duddon Piel Roosebeck	27	26	—	7	2	17
	3. Silverdale	—	4	—	—	2	4
	4. Ansdell St. Anne's Lytham	22	34	60	11	16	18
	5. Blackpool	—	44	40	—	4	10
	6. Fleetwood Wyre Estuary	27	10	50	18	—	20
	7. Morecambe Bolton-le-Sands. Heysham	112	30	20	50	8	50
	8. Ulverston Bardsea Baycliff	12	62	—	5	14	30
	9. Glasson Dock Sunderland Point.	47	—	—	25	—	19
Capt. Eccles	10. Southport Marshside Banks	—	112	29	—	54	69
	11. Formby Crosby Waterloo	—	37	40	—	4	35
	12. New Brighton Liverpool Birkenhead Wallasey	73	—	30	2	14	55
	13. Hoylake	10	—	10	3	5	10
Capt. Jones	14. Conway Bangor Menai Straits Llanfairfechan	80	58	200	46	10	120
Capt. Pritchard	15. Aberdaron Pwllheli Portmadoc Mochras	16	27	45	9	—	54
Mr. R. Davies	16. Aberystwyth	24	11	20	12	—	30
Mr. E. Williams	17. New Quay	Nil	Nil	46	Nil	Nil	Nil
	Total	450	565	590	188	169	591

CHAPTER IV.

The sources from which the large towns of England and Wales derive their shellfish.

Both from an administrative and epidemiological standpoint it is essential that a general idea should be obtained as to the countries and places from which England and Wales obtains supplies of shellfish.

Were England and Wales entirely self-supporting in the matter of shellfish, control would be a much simpler process than would be the case were other parts of the British Isles as well as certain foreign countries also concerned in such supplies.

It is not always easy to ascertain the source of the shellfish in any given case, a circumstance which is due to suspicion both on the part of the retailer and of the wholesale merchant as to the uses to which the information is to be put, and it is clear that one of the reforms which will be desirable will be the registration, not only of all sources of supply, but also of the wholesale dealers to whom shellfish are consigned. It will, too, be desirable to devise some machinery by means of which any given batch of shellfish may be traced through the retail and wholesale salesman to the beds, a fact which will involve the registration of itinerant shellfish hawkers and of shellfish stalls erected in the streets.

But although there is increasing difficulty in ascertaining the places to which shellfish are despatched, I have been able, through the kindness of officers of the Sea Fisheries Committees and of medical officers of health whose assistance I wish here to acknowledge with gratitude, to obtain information as to the principal shellfish supplies of certain of our large towns, and this information has served to show the multiple and often far distant sources from which places in England and Wales are furnished with shellfish.

Although this report deals for the most part with mussels and cockles only, I have in some instances received information as regards oysters as well as certain other shellfish. It is apparent from these returns and from the map No. 2 that shellfish pass freely from one side of England to another, and not only so, but that supplies are obtained, especially in certain seasons of the year, from Scotland, Ireland, Holland, France, and America.

In other words, England and Wales occupy in the matter of shellfish practically the same position as they hold with other food supplies, *i.e.*, a large proportion is introduced from other parts of the United Kingdom and from abroad.

To take, as an example, certain instances, Manchester derives its oysters from places as far apart as America, Holland, and Portugal; its mussels from Scotland, North and West Wales, Lancashire, Devonshire, Lincolnshire, and other counties in England, as well as from numerous places on the coast of Ireland, while as regards cockles, they are introduced from Lancashire, King's Lynn, and Boston.

Bristol, although close to important shellfish centres in South Wales, obtains supplies from the Devonshire coast, from Boston, Lynn and Leigh-on-Sea and also from Ireland.

Newcastle derives its oysters from America, Holland, and Scotland, its mussels from Holland, Scotland, and Morecambe Bay, and its cockles largely from Boston and Hull (these latter being largely of Dutch origin).

The mussels consumed in Birmingham are obtained from Wales, Ireland, Scotland, and Holland, and from numerous English sources, while, as regards Liverpool, oysters are procured extensively direct from America; mussels, cockles, and periwinkles largely from Ireland, and from certain other sources nearer home. Cockles are introduced into Plymouth from the coast of Brittany and from local sources, while Hull is supplied twice weekly with mussels from Harlingen and Rotterdam, and during the season some 20-100 bags of cockles are introduced from Harlingen. About 30 per cent. of the shellfish landed in Hull is consumed in that city, and presumably the whole of such shellfish is of Dutch origin. The remaining 70 per cent. is, it appears, introduced *viâ* Hull into other English towns.

Sheffield obtains cockles from Holland, Boston, Grimsby, and Glenfinnan; its mussels from Hull, Morecambe, Holland, Fleetwood, and Ireland. Halifax procures its cockles from the Lancashire coast and Holland; and its mussels from North Wales and Lancashire.

It is clear from these illustrations that many, both of our seaport and inland towns, derive their shellfish from long distances and from multiple sources, and the importance of this fact should not be lost sight of.

But certain towns appear to be supplied with shellfish from local sources only.

For example, Portsmouth is said to be supplied almost exclusively with mussels and cockles from Portsmouth and Langstone Harbours, and here again the medical officer of health has attributed much of the enteric fever in Portsmouth to shellfish.

Exeter was supplied with mussels and cockles largely from the estuary of the Exe, and at one time much enteric fever in Exeter was traced by the medical officer of health to the consumption of cockles collected near Exmouth.

Southampton is said to derive its shellfish mainly from the estuary of the Itchen.

From what will be found in other portions of this report it is clear that shellfish procured from many distant sources may cause enteric fever and attacks of diarrhœa in places remote from such sources.

There is no valid reason for believing that the conditions as regards risks of contamination to shellfish are any better in foreign countries or in other parts of the British Isles, than they are in England and Wales, and as is now well known, shellfish-borne outbreaks of enteric fever have occurred in almost every country of Europe as well as in the United States of America.

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* The *Times* of July 2, 1909, contained the announcement of an outbreak of enteric fever at St. Brieuc in Brittany, where it was alleged 2,000 cases had been thus caused by the consumption of shellfish collected from the harbour, and the Medical Officer of Health of Guernsey in his annual report for the year 1909 announces that the authorities of this island have in consequence of the outbreak above referred to prohibited the introduction of shellfish from France.

Detailed information is available as regards the conditions under which oyster culture in France is conducted, and from the official report of Dr. Mosny to the French Government, it would appear that at the time such report was made not a few of the oyster layings around the French coast were liable to be specifically contaminated.*

As has been said a large quantity of mussels from Holland are imported into this country mainly for immediate consumption, and it has within recent years been the practice to forward with each consignment a certificate† from the Netherlands Government testifying that the mussels in question had come from unpolluted sources. It is, therefore, important to note that Dr. Collingridge, who has always been fully alive to the possibility of the pollution of foreign shellfish, refers in his annual report for 1908 to cases of enteric fever occurring in the boroughs of Islington and Wandsworth, and which were attributed to the consumption of mussels which on inquiry were found probably to have come from Holland, and Dr. Klein, to whom mussels alleged to have come from the same source were submitted, found evidence of what he regarded as fæcal contamination. Consequently, the Consul-General of the Netherlands was communicated with upon the matter.‡

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* Des maladies provoquées par l'ingestion des Mollusques etude sur la salubrité des établissements ostréicoles par M. le Dr. Mosny, Medicin des Hôpitaux de Paris. Entrait de la "Revue D'Hygiene" (Decembre 1899, Janvier, Février et Mars, 1900), Masson et Cie Editeurs, 120, Boulevard Saint-Germain, Paris, 1900.

KINGDOM OF THE NETHERLANDS.

Valid only for the sending.

†1908. Dated 21 November, 1908.

Certificate.

The Board of Fisheries and the Scheldt at Zealand streams, after personal investigation and personal knowledge, and also on the basis of the topographical and bacillary investigation carried on by its orders for considerable terms at fixed periods, both of the waters and of the oysters and mussels, certifies that the ponds at the breeding grounds of____________ Brunissi, situated within the district of the Scheldt and Zealand streams, are free from noxious microbes and in consequence of their position not exposed to any reasonable risk of pollution by sewage or objectionable filth.

The Board aforesaid,

Signatures of { President and Secretary-Treasurer.

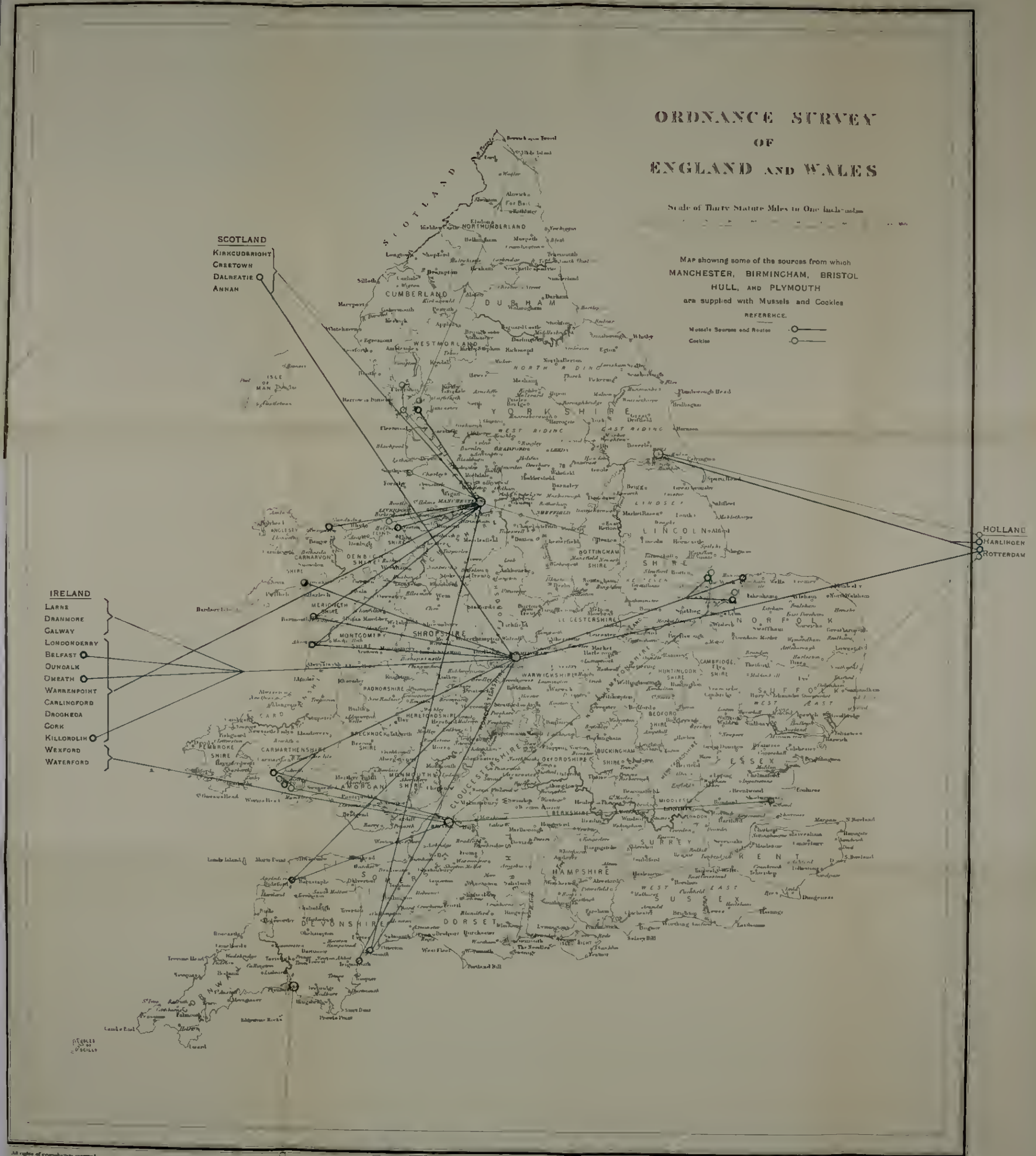
---

‡ Mr. G. H. Baxter, while giving evidence before the Royal Commission on Sewage Disposal in 1902, furnished figures relative to the importation of Dutch Mussels in the years 1900–1902 inclusive, and these figures showed that as regards Billingsgate somewhere about 50 per cent. of the mussels came from North and South Holland.

As regards the certain American shellfish beds, *see* reference to Dr. Soper's investigations in the Report of the Metropolitan Sewerage Commission of New York, 1910.

PSHIRE
Haslem
Alresford
Petersfield
W E
Midhur
Eastleigh
Aru
Fareham
Chichester
Portsmouth
Bogi
Cowes
Ryde
Selsey Bi
WIGHT
Shanklin
Ventnor

MAP No. 2.



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The Supply of Mussels and Cockles from Ireland and the Conditions under which they are sometimes grown.

The returns relative to the sources whence our large towns obtain their supplies of shellfish show that a very considerable quantity of these molluscs are introduced into England from Ireland, and the valuable report made to the Local Government Board of Ireland by Dr. Browne and Professor McWeeney enables a judgment to be formed as to the conditions as regards shellfish growing which obtained at the date of that report.*

It will be seen by a perusal of the abstracts and extracts now furnished that legislation which does not embrace Ireland will fail signally in its purpose.

It may be here mentioned that from the annual report of the Department of Agriculture and Technical Instruction on the Sea and Inland Fisheries of Ireland for 1907, it appears that the quantity of mussels exported in that year was 1,956 tons. The annual export since 1901 having averaged about 1,980 tons.

The principal sources of supply are Belfast Lough, Castlemaine Harbour in Kerry, Dundalk and district, River Boyne, Drogheda and Wexford Harbour.

It is stated in that report that the majority of the Belfast mussels go to Scotland, while the manufacturing towns in the northern and midland counties of England take most of the remainder, the demand for large well-fished mussels being greater than the supplies which have hitherto been utilised.

The government department concerned has been apparently engaged in opening up other markets for the Irish mussels, and during 1907 they caused samples to be sent to various English markets from Oranmore and Clarenbridge, in Galway Bay, and from the Kenmare River and Glengariffe Harbour. Manchester at once gave extensive orders for Galway mussels, and the railway companies lowered their rates in order to promote the trade. Although there is no well-defined season for the Irish mussels, it may be said to extend from October to the middle of March. Demonstrations of mussel culture and relaying operations have been given in Galway Bay and Glengariffe Harbour.

Cork Harbour

Three boats are engaged in dredging operations from the middle of October weekly to the middle of May, and about 50 bags of mussels are exported during this period to Messrs. Mussen, Liverpool*. They are shipped direct from Cork three times a week. Dr. Browne adds that he has been unable to ascertain whether the mussels are eaten or used as bait for fishing, but he thinks that they are probably applied to both uses. As regards pollution, he regards the mussels as contaminated to a much greater extent than the oysters in the same river.

Cockles.

" A few women are employed collecting cockles from March to September " on Meelough Strand, and from Blackrock Castle on the strand to a point " opposite Hop Island, in Douglas Channel, as well as at Bawnard Creek, on " the Ballinacurra River; a few bushels of periwinkles are also gathered from " Bawnard Strand each week and shipped to London. The cockles are " disposed of in Cork, and are as a rule eaten cooked."

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* Report on the Shellfish Layings on the Irish Coast, 1903. [Cd. 1900.] Price 7*s.* 4*d.*

Castlemaine Harbour, County Kerry.

Dr. Browne reports that some 200 persons are employed in dredging for mussels from October 1st to the middle of March, about 500 tons of mussels being obtained from the bed each season. The mussels are bought by local dealers and despatched in bags by rail to wholesale dealers in Bradford, Birmingham, Liverpool, Manchester, Nottingham, &c. Dr. Browne regards the risk of pollution to these mussels as very small.

Galway Bay.

The few mussels which are collected here are exported mainly to Liverpool and Manchester. Only those collected near Galway are, Dr. Browne thinks, subject to pollution.

Periwinkles are also exported to London, Liverpool and Manchester, but they are not, it is alleged, taken from localities liable to pollution.

Ballysodare Bay.

Some 30 persons are occupied hereabouts in the picking and dredging of mussels, about 20 tons being annually collected between October and March. They are despatched in bags from Sligo to Liverpool. Dr. Browne considers that there is little or no risk of contamination to these beds.

Sligo Harbour.

About 50 tons of mussels are collected annually from October to April in this locality, and are despatched by rail and steamer to the London, Liverpool and Manchester markets. Dr. Browne regards the beds as subject to contamination.

Lough Foyle.

Mussels are collected hereabouts, but they are either despatched to Scotland for use as bait or used locally as manure. They are not, Dr. Browne reports, polluted.

Carlingford Lough.

About 21 tons of mussels are annually collected on the shores of Carlingford Lough and Newry River, and despatched to the Liverpool and Manchester markets by steamer. I gather from Dr. Browne's report that shellfish in the Newry River are liable to pollution.

Belfast Lough.

The greater part of the mussels, periwinkles, &c., are sent to England and Scotland, the mussels being used principally for bait, but the cockles are disposed of in Belfast. They are hawked in the evenings through the working class districts, sold to the residents and in public-houses. Rag gatherers frequently hawk them and exchange them to children for rags and bones.

As regards the liability of specific pollution to which the Belfast mussels are exposed, the following extract from Dr. Browne's report will suffice :—

" Mussels are collected in Belfast Lough along the foreshore at low water " on the northern side from Macedon Point, Lower Whitehouse, to within a " short distance of the pumping station in connection with the sewerage " system of Belfast, at within 50 yards of the sewer outfall. On the " southern side of the Lough mussels are collected at low water on the fore- " shore between Tillysburn, Sydenham and East Twin Island. Mussels are " collected all the year round, but chiefly from August to May. About " 60 tons are exported weekly during these months to Aberdeen, Peterhead, " Fraserburgh and Berwick, to be used for bait for fishing purposes. " Some are also sent to Liverpool and Manchester and are used as food. " Large quantities are also collected by the working classes in Belfast on " holiday and at other times, and are eaten by them either in a raw state " or cooked."

As regards cockles in Belfast Lough, Dr. Clibborn, one of the Medical Inspectors of the Irish Local Government Board, in a memorandum addressed to Dr. Browne, states :—

" The sale of cockles gathered on the foreshore of Belfast Lough, although " not so extensively carried on as formerly, is still of considerable importance ;

" but the quantity gathered by the general public (who come from nearly " every part of the town) and carried home for consumption, probably " exceeds to a large extent that gathered by those who earn their living by " this occupation. As many as 50-60 persons have been counted gathering " cockles in one day, close to the sewage outfall works, and these people are " not so particular as to the cleanness of the shellfish, often picking up those " which are highly discoloured and show up on the surface of the slob-" land. Many cases of typhoid have occurred in houses where this class " of shellfish has been used.

Dr. Clibborn then furnishes a list of recent cases of enteric fever, in which it was admitted that the patient had eaten cockles a fortnight or three weeks prior to the onset of the illness. There are, he adds, " many instances " where the patients suffering from enteric fever have denied eating shellfish, " although the sanitary inspector has found the empty cockle shells in the " ashpit."

In the *Lancet* of February 10th, 1900, page 421, Dr. Otto Jaffe referring to the excessive prevalence of enteric fever in Belfast suggests that contaminated cockles might be responsible for this incidence. He points out that the 700 Russian Jews in Belfast seem generally exempt from the disease, a circumstance which he was inclined to attribute to the fact that by the Mosaic Code the consumption of all animals living in the sea and not covered with scales is forbidden.

Dundalk Bay, County Louth.

Estuary of Castletown River.

Mussels are collected near Dundalk from August to the end of May, six boats and some 30 persons being employed in the industry. About 150 tons are collected annually and despatched in bags by steamer and rail to wholesale fishmerchants at Manchester. The mussels are apparently liable to gross contamination.*

Estuary of the River Boyne.

Nineteen boats are engaged hereabouts in mussel dredging from October 1st to March 31st, and during the close period for salmon fishing about 60 tons of mussels are sent to Liverpool and Manchester. The mussels are not, Dr. Browne states, free from suspicion of contamination.

Wexford Harbour.

Some 20 persons are engaged in dredging operations in the harbour from October to the end of April, about 30 tons being collected each season. They are shipped direct to Bevis of Bristol and Balfour of Liverpool.

The mussels dredged near Wexford are, it is stated, subject to gross pollution, and those dredged further down the harbour to pollution in a smaller degree. Dr. Browne reports that, according to his information, mussels are sometimes deposited in bags quite close to the sewer outfall, where they are liable to gross pollution.

Waterford Harbour.

Some 5 tons of mussels are collected annually in this harbour and sent by steamer to Liverpool and Manchester.

There is apparently little risk of contamination to shellfish in this locality.

Imported Periwinkles.

About 1,500 tons of periwinkles are exported from Ireland to London, Liverpool and Manchester. They are not consumed in Ireland as a food.

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* Two cases of enteric fever at Leigh in Lancashire in 1909 were attributed to Dundalk mussels, and the Local Government Board of Ireland stated that there was undoubtedly sewage pollution of the mussel beds in Dundalk Harbour.

CHAPTER V.

The Behaviour of Enteric Fever in England and Wales during the last thirty years.

With the view of illustrating graphically the mortality from enteric fever in England and Wales during each of the decennial periods 1871-80, 1881-90, and 1891-1900, Chart No. 1 has been constructed from the last three decennial supplements of the Registrar-General.

In this chart the counties of England have been arranged from left to right according to the magnitude of the death-rate in each county during the first decennial period dealt with, *i.e.*, 1871-80.

It will be seen from this chart that in each of the periods in question there has been an enormous death-rate from enteric fever in the counties of Durham, Lancashire, Yorkshire, Nottinghamshire, and Northumberland, and that, generally speaking, such excess in relation to the mortality of other counties has been maintained in each subsequent decennium.

It will be noted, too, that a very great decline took place in the enteric fever death-rate in every county of England and in North and South Wales between 1871-80 and 1881-90, and there was not a single instance in which a very material fall did not occur.

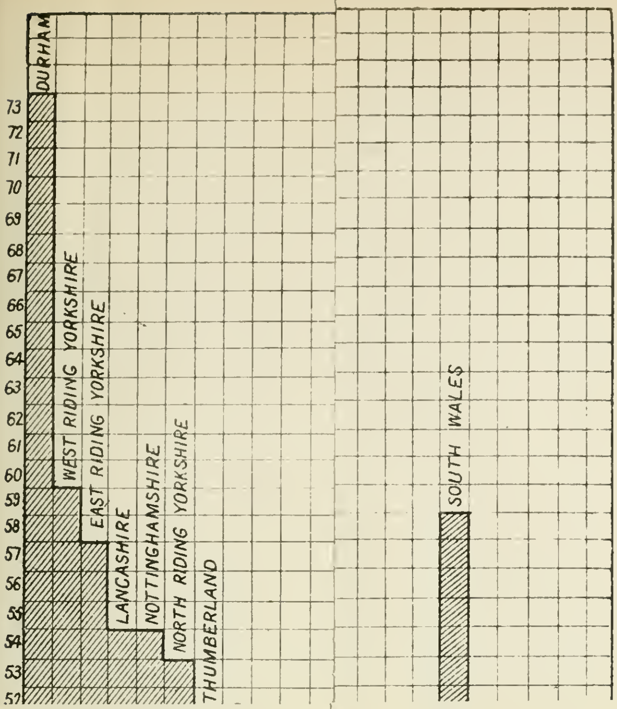
But it is also apparent from this chart that between the last two decennial periods the fall in enteric fever mortality in the vast majority of cases was markedly less than was the case between the two first decennia, and that in the case of three counties—Durham, Stafford, and Warwick—there was actually an increase in 1891-1900, while, as regards Sussex, the rate remained stationary.

In the case of Lancashire, Yorkshire, and Nottinghamshire the fall in enteric fever mortality, compared with that which took place between the two first decades, has been but small, and a similar observation holds good of counties such as Suffolk, Hertfordshire, Bedfordshire, Leicester, Cheshire, Lincoln, Norfolk, and Essex.

The rates from 1891-1900 were heaviest in Durham, Lancashire, Nottinghamshire, and the East Riding of Yorkshire, and they were lightest in Hertfordshire, Rutland, Oxfordshire, and Berkshire.

From Chart No. 1 considered alone it would therefore appear that between 1881-90 and 1891-1900 there was a distinct inhibition in the decline in enteric fever mortality, which took place between 1871-80 and 1881-90, and it will be of interest to examine the behaviour of the disease in the country as a whole in the separate years over the period dealt with. This can be conveniently done by reference to Chart No. 2, which represents the death-rate from enteric fever per 100,000 of the population for each year from 1869 to 1908 as well as the death-rates from continued fever and from typhus fever.

The two latter diseases have been introduced upon the chart to bring out the fact that the decline which has taken place in enteric fever is in large part real and not apparent only, that is to say that such decline is not wholly due to transference of cases of enteric fever to the group either of continued or typhus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DURHAM
WEST RIDING YORKSHIRE
EAST RIDING YORKSHIRE
LANCASHIRE
NOTTINGHAMSHIRE
NORTH RIDING YORKSHIRE
THUMBERLAND
SOUTH WALES

CHART No. 1.

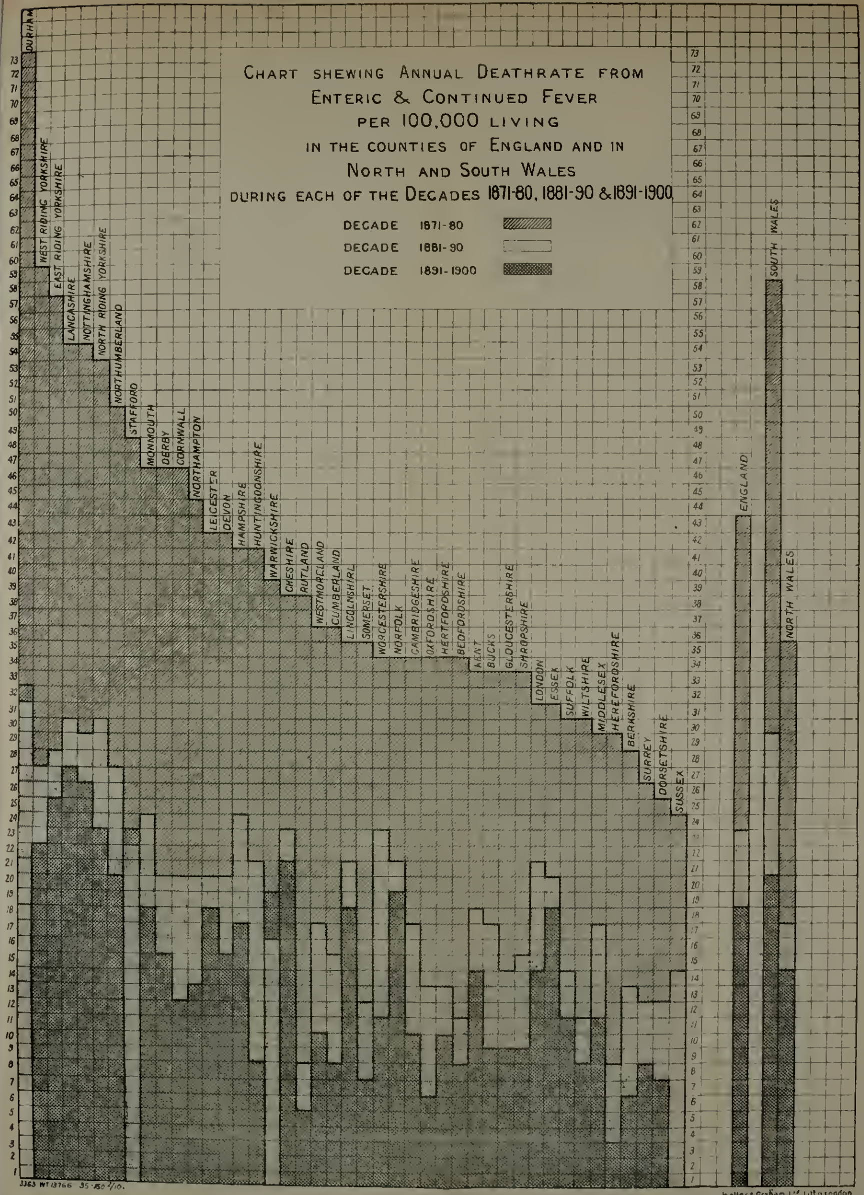

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CHART Nº 2.

ENGLAND & WALES

CHART SHOWING DEATH RATE FROM
ENTERIC FEVER ___ CONTINUED _ _ _ _ AND TYPHUS .... FEVER
FROM 1869 TO 1908.
PER 100,000 POPULATION.

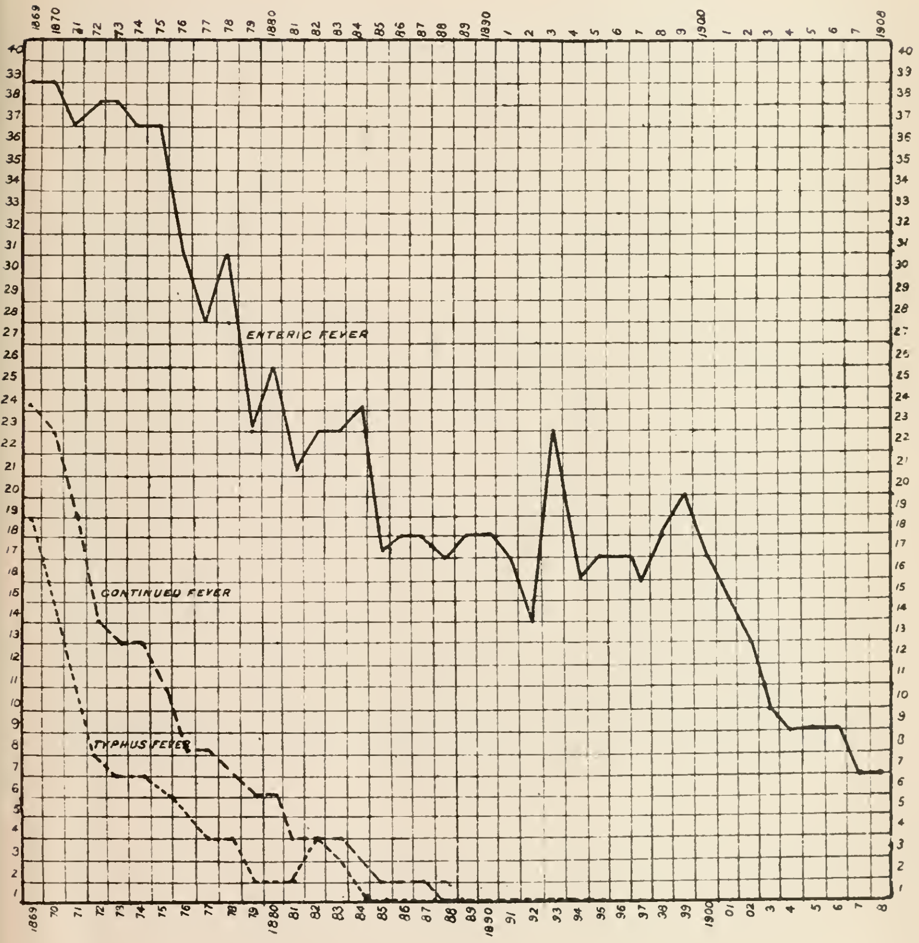

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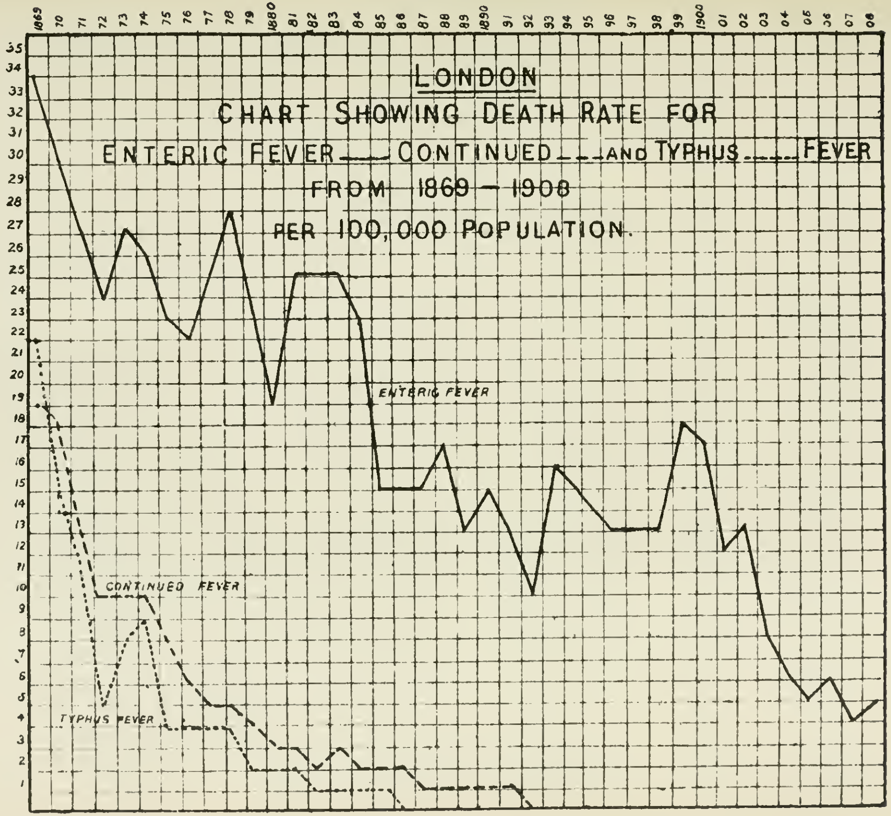
CHART Nº 3.



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fever, both of which have undergone a rapid decline since they were statistically separated from enteric fever by the Registrar-General in 1869.

It will be seen that by the year 1895 both had disappeared from a chart exhibiting the death-rate per 100,000 of the population.

The enteric fever curve on this chart shows that between 1875 and 1885 there was, with sundry oscillations, a rapid decline in enteric fever mortality, but that between 1885 and 1899 the death-rate for this disease for the country as a whole remained almost stationary. From the commencement of the present century, however, there has been a steady fall, which is of happy augury for the future.

The enteric fever death-rate curve for London alone, which is set out on Chart No. 3, shows practically an identical tendency to that manifested in Chart No. 2, except that in the case of London there was a marked decline between 1869 to 1872.

The type of Enteric Fever caused by Shellfish is not improbably a severe one with a high fatality-rate and a short incubation period.

The data upon which the above provisional suggestion is based are not as yet sufficiently numerous for reliable statistical inferences, but observations made by several medical officers of health, both independently and in answer to enquiries from me, suggest that in the case of shellfish-borne enteric fever the virus may be of high intensity.

For example, Dr. Mearns Fraser in his annual report for 1907 states that out of the 80 persons who contracted enteric fever through shellfish 14 or 17·5 per cent. died, whereas of the remaining 153 cases in only 16 or 10·5 per cent. was there a fatal termination. Assuming the age distribution of the cases to have been approximately identical, this evidence is of interest. Dr. Nash, as the result of his clinical experience at Southend, came to the conclusion that the cases of enteric fever which were caused by the eating of raw shellfish or more particularly, perhaps, of raw cockles were exceptionally severe, whereas cases of that disease following upon the consumption of cooked cockles were of much milder type. It may be noted that this observation as regards cockles is in keeping with the bacteriological researches of Dr. Klein, who found that the vitality of the Eberth-Gaffkey bacillus was materially greater in cockles than in oysters or mussels.

With reference to the short incubation period a very large number of cases of alleged shellfish-borne enteric fever have been brought to my notice in which the incubation period was very short indeed—often not more than two or four days. Either the pathogenic bacilli in these cases were of high virulence or the inference that the shellfish were the cause of the enteric fever was not justified.

CHAPTER VI.

A digest of some of the evidence available relative to the connection which obtains between the consumption of certain shellfish and the development of enteric fever or other illness.

It is desirable that an account should now be given as to the reasons which have led to the conclusion that certain shellfish are at times and in places instrumental in promoting outbreaks and in causing sporadic cases of enteric fever and other illness of a more transitory and sudden character.

It would seem advisable in the first place to make a few observations with regard to the nature of the evidence which is alone available in investigations of this nature.

Such evidence must of necessity be circumstantial since absolute proof in dealing with epidemiological problems, such as are here involved, is practically unattainable. Moreover, the evidence in this instance must be not only circumstantial but largely cumulative, that is to say, made up of a succession of associated events repeated sufficiently often to bestow upon them a definite value *quâ* evidence.

It is, of course, of little importance to know that certain persons who develop enteric fever have consumed raw shellfish since this fact in the present state of our knowledge merely implies that such persons have recently eaten something which is believed, under certain circumstances, to be capable of causing enteric fever or other gastric disturbances. But this fact alone has little, if any, more value than the bald statement that the patient had consumed water or milk, had inspired drain air, consumed raw vegetables, or lived in a house where the conservancy system of excrement disposal obtains, all of which articles or circumstances are to be thought of as being capable of inducing attacks of enteric fever.

It is clearly essential to know not only at what date or dates shellfish had been eaten, but also to what other sources of infection, if any, the patient had been exposed.

But not infrequently the mere statement "had eaten shellfish" is considered sufficient for the inference that this was the cause of the illness, no other possible sources of infection having been looked for or at least discussed, albeit other cases of enteric fever are ascribed to other causes such as those above referred to.

But even if the shellfish could be shown to have come from a source liable to pollution and to have been consumed raw at a date consistent with its causation of enteric fever, the two events need by no means be causatively related since, for example, had the case in question been one of a group which had apparently been infected by milk, water, or foods other than shellfish, the cumulative evidence pointing to the latter agents would outweigh that in connection with a single event.

It must not be forgotten, too, that the etiological value which is to be attached to the circumstance of an enteric fever patient having eaten shellfish within, say, three weeks of the onset of the disease depends very largely upon the proportion of the population which habitually or even occasionally consumes shellfish.

If the consumption of shellfish in any given locality is a more or less routine custom indulged in, at times, by a large percentage of the population it will, of course, be probable that in some instances there will be an association in point of time between the shellfish eating and the onset of enteric fever without there being any necessary causal relationship between the two events; in fact were the consumption of shellfish as common as the consumption of milk the value of the statement that a patient had eaten shellfish within a short period prior to attack would, having regard to the relatively small number of cases of enteric fever, have no more etiological significance considered alone, than the statement that the patient had consumed milk, both of which articles are liable to be contaminated by polluted water.

The Proportion of the Population which habitually consumes Shellfish.

The data available as to the proportion of the population which is in the habit of consuming shellfish such as are here under consideration are very scanty, but such as they are they would seem to point to the conclusion that such proportion is a small one.

In September of the year 1900, Dr. Hamer, when inquiring into a local outbreak of enteric fever in Southwark, found that about 50 per cent. of the families living in the invaded area had one or more shellfish eaters in each family, and Dr. Joseph Priestley, who inquired into the question in connection with cases of infectious disease other than enteric fever in Lambeth, found that in 100 cases 37 had eaten shellfish in the earlier two of the three weeks preceding the attack.

Some computations were made in the year 1902 by Dr. Niven of Manchester and Dr. Nash of Southend. The former, as the result of an investigation made in Manchester in the year referred to, found that in 1,354 houses, inhabited mainly by artisans, shellfish had been used at one or another time during the previous year, in 384 houses, *i.e.*, in about 28·4 per cent. of the houses in which inquiries were made.

In the investigations made by Dr. Nash questions were asked at 656 houses at which cases of infectious diseases, inclusive of chicken-pox had occurred, the inquiries being made in all parts of the borough.

It was found that with only two exceptions the only shellfish eaters in this inquiry were found in houses in which enteric fever had occurred.

Dr. Nash has arrived at the conclusion that in Southend less than 5 per cent. of the population eat shellfish, and on the assumption that precisely 5 per cent. do so, he has calculated the incidence of enteric fever in the respective groups to be as follows:—

	Per 1,000
For the entire population	5·0
For the shellfish eating section	56·0
For shellfish merchants and employees	160·0
For the remainder of the population, even including these secondary and shellfish cases only	2·3

He found that on the 5 per cent. assumption the incidence of enteric fever on the shellfish eaters was at least 36 times as great as upon the non-shellfish eating section—*ceteris paribus.*

Dr. Hamer has drawn my attention to an investigation, which at his suggestion was made in the Metropolitan Borough of Bethnal Green in October, 1908, by Mr. Henby, the sanitary inspector of that part of the borough in which an outbreak of enteric fever had occurred, the investigation being undertaken with a view to determining the habits, *quâ* shellfish consumption, of the class of persons amongst whom the prevalence of enteric fever occurred.

Inquiries were made at 36 houses containing 67 families and 283 persons, and it was ascertained that the percentage of adults who had eaten mussels was 22·5, the percentage of children alone 5·5, and the percentage of adults and children considered together 14·75.

It was further found in the outbreak of enteric fever here referred to, that 29 per cent. of the patients had eaten mussels and 44 per cent. fried fish.

In the winter of 1908, my colleague, Dr. R. W. Johnstone, investigated an outbreak of enteric fever in the urban district of Ormesby in Yorkshire, in the course of which he was led to make inquiry into the relation of shellfish to the outbreak. His researches in this particular case are set out as follows in his report*:—

"Out of 62 cases in which inquiry was made it was found that "16 had eaten shell-fish within a period of 5 to 21 days before the "onset of enteric fever. That is 25·8 per cent. of those questioned "had eaten shell-fish a short time previous to their illness. In "order to obtain some figures with which to compare this percent-"age, a census was made of two or three typical streets in North "Ormesby, and inquiries were made as to the consumption of "shellfish, ice cream, fried fish, and later on of uncooked vege-"tables. Inquiries as to shellfish were made at 174 houses, and "it was found that in 16 shellfish of one sort or another were "consumed in the summer of 1908. 827 persons were inter-"rogated and 60 of them gave affirmative replies. That is 9·2 "per cent. of the houses, and in the case of 7·3 per cent. of the "individuals, shellfish had been taken during the summer of "1908. It appears then that amongst those attacked by enteric

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* Dr. R. W. Johnstone's Report to the Local Government Board upon an outbreak of Enteric Fever in the Urban District of Ormesby. (New Series, No. 17) 1909. Wyman & Sons, Ltd., Fetter Lane, E.C.

" fever there were more than three times as many persons who had " eaten shellfish during the period of 5 to 21 days preceding their " illness as was to be expected from the figures obtained at the " local census. The disproportion is much more marked when " it is considered that the census inquiry included the whole " summer, while the inquiry made from patients included only " a particular period of 16 days. These figures afford strong " presumption that the consumption of specifically infected shell- " fish contributed to spread enteric fever in North Ormesby " during 1908."

Evidence as to Multiple Cases and repetition of Associated Events.

The evidence relative to the causal action of shellfish approaches a different order where multiple cases are concerned and where associated events are repeated.

For instance, the associated events which first drew attention to oysters as enteric fever bearers were somewhat as follows:—

Four friends from the country dine together at a restaurant in London or elsewhere, and, *inter alia*, consume oysters. Three weeks or so later all are attacked with enteric fever or three with enteric fever and one with gastro-enteritis.

Here the evidence, as it stands, although suggestive, is in no sense conclusive, as conceivably the four friends may also at their repast have partaken of water or unboiled milk, salad, or water-cress, or possibly some other article of food which may have been contaminated by a cook or attendant who was a " carrier " case of enteric fever. Nevertheless it would not be difficult by careful inquiry to eliminate both the water and the milk or other foods, and thus to emphasise the influence of the shellfish.

But a stronger case against the shellfish would take the shape of one in which four friends enter an oyster bar for the specific purpose of eating oysters and nothing else, this being the only occasion when they consumed food together in common. If they all developed enteric fever or even two so developed it—within the incubation period—while one or both the others suffered from attacks of gastro-enteritis the case would be an extremely strong one, as also would an instance of four persons dining together, three of whom took oysters while the fourth abstained, the former developing enteric fever, the latter remaining well.

But even an instance such as this—considered alone—would lack demonstrative value if it could be shown that a larger number of persons consumed oysters from precisely the same consignment without ill-effect.

But repetition of occurrences such as these spread over many years and occurring in several different places do, without doubt, make up a body of evidence which greatly enhances the probability that in any given case the shellfish have been responsible for the enteric fever, and this probability becomes materially strengthened when it is recognised, as it certainly must be recognised, that shellfish are not infrequently grown, fattened, or stored under conditions which perhaps invite their pollution by sewage.

When, too, it can be shown, as it has been shown, that the sewer or drain, discharging near to the shellfish beds or storage ponds from which the shellfish in question were taken, came from a house or houses in which cases of enteric fever were actually dwelling the region of demonstration begins to be approached.

It must be borne in mind that the fact of many persons who consumed shellfish having remained free from illness of any description while a few only were attacked does not justify the conclusion that the shellfish were not the cause of the illness in those who suffered. As is well known to all epidemiologists only an uncertain proportion of those who consume an infected medium such as water or milk develop the disease which may be in question in any given instance. For a " disease " to be produced two factors are necessary, the specific organism and a susceptible condition of " soil " or tissue, and it has of course to be remembered that even in media such as water or milk the disease organisms are not uniformly distributed, and in the case of shellfish this is less likely to be the case.

Moreover, emphasis must be laid upon the fact that actually specific infection is likely to be transient in character so that the circumstance that the specific organisms of the disease in question cannot be detected even shortly after the illness has presumably been produced by shellfish is but of little value in negativing the shellfish hypothesis, and a similar statement holds true with regard to the exemption of persons who have consumed shellfish from the same locality at apparently the same date. It it not inconceivable that infection may in any given instance be a matter of one tide alone. That is to say, infection may reach the shellfish beds or ponds on the ebb of one tide and be removed by the flood of the next.

Although it is but rarely that in any given outbreak or group of cases the element of doubt can be entirely excluded the inference that the shellfish were the cause of such outbreaks may from an administrative standpoint be fully justified.

For were action postponed until absolute proof was forthcoming preventive medicine as an administrative force would practically cease to exist, and, as in most human affairs, action has to be taken on a balance of probabilities rather than on a demonstrated basis.

Well attested Shellfish-borne Outbreaks of Enteric Fever and Gastro-enteritis.

As illustrations of well-attested outbreaks of enteric fever and other illness due to the consumption of shellfish, the historical instances of the Connecticut and Winchester oyster-borne outbursts may be briefly summarised, since they serve to show how near to positive proof this evidence may sometimes approach.

The former of these occurred at Wesleyan College, Connecticut, United States of America, in the autumn of the year 1894,* and the latter in the winter of 1902,† after the mayoral banquets which were given at Winchester and Southampton respectively on November 10th of that year, and which were followed in each instance by many attacks of enteric fever and numerous cases of gastro-enteritis.

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* Seventeenth Annual Report of the Board of Health of the State of New York. *See also* Oyster Culture in Relation to Disease. Twenty-fourth Annual Report of the Local Government Board. Supplement in continuation of the Report of the Medical Officer for 1894–95. Eyre and Spottiswoode.

† Report of the Medical Officer of the Local Government Board for 1902–03. Eyre and Spottiswoode. 1904. [Cd. 2213.] Price 8*s.* 6*d.*

In the case of Wesleyan College there took place a form of commemoration supper which was attended by about 100 students who were made up of seven different fraternities. Some three weeks after the supper there occurred multiple cases of enteric fever not only amongst the then students but also amongst old students who had come up from various parts of the United States to be present at the annual festival. On carefully investigating the distribution of the cases amongst the several fraternities it was found that the cases were practically confined to three of the fraternities. All the recognised causes of enteric fever such as water, ice, milk, sanitary circumstances, &c., were examined with negative results, and all the articles on the menu were gone through and excluded until the oysters were considered. These molluscs were at once found to answer the requirements necessary to explain the outbreak in practically every particular. The three fraternities invaded in such large proportion were the only fraternities which had consumed raw oysters, and the oysters themselves were found to have been derived direct from a fattening ground or "laying" within 300 feet of a private sewer or drain from a house in which, at the time the oysters were deposited, two persons were incubating enteric fever.

The other outbreaks which occurred at Winchester and Southampton were shown after a careful analysis of all the menus filled up by persons who had attended the banquets to have been alone explicable on the view that oysters were the cause, and it was found that such oysters had been stored prior to consumption in a pond upon the foreshore of a town where they were liable in a high degree to become polluted by sewage.

It was similarly ascertained that the very large number of cases of gastro-enteritis which occurred at each banquet could be best explained by the circumstances that they were due to the oysters they consumed.

The following is a brief summary of the facts in connection with this remarkable explosion of illness:—

1. Two mayoral banquets occur on *the same day* in separate towns several miles apart.
2. In connection with each banquet there occurs illness of analogous nature attacking, approximately speaking, the same percentage of guests and at corresponding intervals.
3. At both banquets not every guest partook of oysters, but all those guests who suffered enteric fever and approximately all those who suffered other illness did partake of oysters. The exceptions to this rule appear insignificant when all the facts are marshalled.
4. Oysters derived directly from the same source constituted the only article of food which was common to the guests attacked.
5. Oysters from this source were at the same place and at other places proving themselves competent causes of enteric fever.

In his annual report for 1904, Dr. Newsholme, when medical officer of health of Brighton, records a serious outbreak of gastro-enteritis occurring amongst the members of a supper party of

13 persons, of whom eight partook of oysters and were attacked shortly afterwards with serious illness. One who partook of oysters remained well, as also did four other members of the party who took no oysters. All who were ill were attacked on November 10th, two days after consumption of the shellfish.

It is proposed now to furnish certain illustrative types of mussel and cockle-borne outbreaks of illness of one or another character since it would be impracticable to discuss all the alleged outbreaks and cases which have occurred even within quite recent years.

It will be convenient to deal in the first place with mussel poisoning since the importance of this question has not been quite adequately realised, and it is well to accentuate the fact that enteric fever is not the only diseased condition which is liable to be induced by the consumption of shellfish, *toxic conditions and violent gastro-enteritis being in fact much more common sequelæ of shellfish eating than enteric fever,* relatively frequent as such cases undoubtedly are.

Poisoning by Mussels.

It has for many years been a matter of general knowledge that the eating of the common mussel (*Mytilus edulis*) has been followed after a very short period of time by attacks of vomiting, abdominal pain, urticaria, and collapse, and, sometimes, loss of consciousness, such conditions having not infrequently ended speedily in death.

It is a significant fact in relation to the etiology of such illness that in a very large proportion of the cases, if not all, the mussels associated with the illness were procured from places or positions to which sewage and other eminently undesirable filth had opportunities of gaining access. Illustrations of this form of mussel poisoning are herewith furnished.

In 1827 some thirty persons were severely affected—in two cases fatally—after eating mussels taken from the dock gates at Leith, and a cat and dog to which some of the mussels were given were similarly affected.*

In 1857† a ship's crew at Hartlepool were poisoned by mussels gathered from the lower part of the dock wall.

In 1860‡ a number of persons at Tralee were attacked after eating mussels taken from the bottom of a ship canal.

In 1862 several persons were attacked—one fatally—after eating mussels taken from a ship while in Birkenhead Dock, and

In 1872,§ a man, aged 31, died as the result of eating mussels collected from some dock gates. His brother was also seized with illness after eating some of the mussels, but two other men and a dog who ate large quantities of mussels taken from the same source remained quite well.

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* *See* Paper by Dr. James Combe in Vol. XXIV., *Medical and Surgical Review.*

† *British Medical Journal*, August 1st, 1857.

‡ *The Principles and Practices of Medical Jurisprudence*, Vol. I.

§ *British Medical Journal*, 1872, Vol. II., p. 591.

In 1880, a girl, aged seven years, who ate mussels from a quay at Port Glasgow, succumbed from mussel poisoning.

In Vol. 3 of the London Medical Repository, Dr. G. M. Burrows records two cases of mussel poisoning which occurred at Gravesend in boys aged nine and fourteen respectively, who ate mussels gathered from the bottom of a ship and which were apparently dead.

In 1880, Dr. M. K. Robinson* reported two cases in which the mussels had been procured from near the Ramsgate outfall, and in 1889 illness was traced to the consumption of cockles procured from the same locality.

In 1885 the well-known Wilhelmshaven cases occurred. In this instance the mussels were procured from the bottom of the vessels in the harbour, and it is said that the mussels although quite "fresh" emitted a disagreeable odour.

In 1888 three cases of mussel poisoning occurred at Liverpool, the molluscs having been procured from the bottom of a vessel in one of the graving docks. One case ended fatally, the patient having suffered from paralysis of the voluntary muscles and absolute unconsciousness.

In 1890 there occurred what was known as the "Seafield calamity," where a mother and four children died from the effects of eating mussels which had been secured from a locality to which sewage found access.

Mussel and Cockle-borne Enteric Fever Outbreaks.

As regards enteric fever the evidence is obviously of more recent date seeing that this disease was not differentiated from typhus fever until 1869, *i.e.*, until after the date at which the first cases of mussel poisoning mentioned in the foregoing summary occurred.

So far as I am aware, the first cases of enteric fever definitely attributed to the consumption of mussels were recorded by Dr. M. K. Robinson, medical officer of health to the East Kent Combined District, in his annual report to the Broadstairs Urban Sanitary Authority for 1883, the cases in question having apparently been caused by the consumption of uncooked mussels procured from near the outfall of the Ramsgate sewer. Some of the mussels involved were eaten by the sister of one of the sufferers and she, too, was shortly afterwards attacked with vomiting and diarrhoea, but did not develop enteric fever.

Commenting upon these cases Dr. Robinson observed:—

"If milk or water can act as a vehicle for the conveyance of enteric fever contagion, which is known to be the case, there is nothing unreasonable in believing that mussels gathered at the mouth of a sewer and consumed in a raw state might prove also capable of communicating the disease."

In 1894, Dr. F. Cecil Piggott, medical officer of health for Teignmouth, attributed certain cases of enteric fever to the consumption of mussels and cockles obtained in proximity to the outfall drain of the infectious diseases hospital. He was not altogether satisfied that the excreta from the enteric fever patients in the hospital at that time were thoroughly disinfected, and it was quite clear that the topographical conditions which obtained between the mussels and the outfall were such as to directly invite specific pollution.

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* *Lancet*, 1880, Vol. I.

Dr. Wellesley Harris, formerly medical officer of health of Southampton, records in his annual report for 1896, the case of three sailors who had eaten mussels procured from near the main sewer outfall. All three were attacked with vomiting and diarrhoea and two of them subsequently developed what appears to have been enteric fever.

Dr. John Woodman, medical officer of health of Exeter, refers in his annual report for 1899 to several cases of enteric fever amongst children who had attended school treats at Exmouth, and who had partaken of raw cockles either at or taken from that place.

He states that on visiting Exmouth it was found that within a few months the sewage of a portion of the lower part of Exmouth had been diverted into the brook that formerly only took the Withycombe sewage (cases of typhoid being known to have occurred at Exmouth in the part from which the sewage was diverted). This stream discharged over the mud banks from which the cockles were usually taken.

Representations were made to the Exmouth Urban District Council, who, it is stated, took steps to prevent the gathering of cockles from the area in question, and within a short time there was a marked diminution in the number of cases of enteric fever notified in Exeter. It may be added that such diminution was perhaps partially due to the termination of the holiday period.

In the same year Dr. Thresh, county medical officer of health of Essex, and Mr. Walters, medical officer of health of Southend, attributed an outbreak of enteric fever at Shoeburyness to cockles.

Dr. R. W. C. Pierce, medical officer of health of Guildford, in his annual report for the year 1904, refers to an interesting outbreak of enteric fever and gastro-enteritis which occurred after the consumption of "butter-fish"* sent to Guildford from some friend at Portsmouth and which was collected from a bank situated within 300 yards of the main sewer outfall. Thirteen persons partook of the shellfish in question and all, within an interval varying from a few hours to a few days, suffered from severe symptoms suggestive of food poisoning. Four of the persons attacked did not recover completely from the early symptoms and enteric fever gradually supervened.

Most of the "butter-fish" were eaten in a raw state, but some were kept overnight in strong salt and water.

Some of these shellfish were eaten by friends at Aldershot and one of those who partook developed enteric fever. In this instance the shellfish were said to have been boiled.

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* This shellfish (Tapes decussata) is eaten fairly extensively in Devonshire, Hampshire, and Sussex. It is known in some parts of England as "Purr" and in Hampshire as "Butter-fish." Many species of Tapes are eaten abroad. "Edible British Mollusca," by M. S. Lovell. *See also* Woodwards "Manual of Mollusca."

Dr. T. H. Jones, medical officer of health of the borough of Weymouth, refers in his annual report for 1904 to the occurrence of two cases of enteric fever and several cases of diarrhœa which occurred at Dorchester and which were ascribed to cockles purchased in Weymouth.

It appears that on November 26th a Dorchester fish hawker bought 1½ pecks of cockles from two men in a public-house at Weymouth. Half this quantity he sold to a man who consumed them, after cooking, with no ill effects, and part of the remainder he sold in small quantities to persons who ate them uncooked.

The cockles which were unsold were kept by the hawker until November 28th, when small quantities were again sold.

Next day the hawker (who had also eaten cockles) and two or three of his customers suffered from diarrhœa and abdominal pains which lasted for four or five days, but others who had eaten of the same cockles were unaffected.

The cockles were obtained from a source stated to be liable to contamination.

From the foregoing illustrations, which could be supplemented without difficulty, it will have become apparent that circumstantial evidence, approximating as nearly to proof as is practicable in investigations of this nature, points to the conclusion that numerous outbreaks of enteric fever, of gastro-enteritis, and of obscure intoxications are to be attributed to the consumption of certain shellfish (oysters, mussels, and cockles).

The Influence of Polluted Shellfish in maintaining Enteric Fever Prevalence.

But in addition to shellfish-borne outbreaks there is evidence of a somewhat different but cumulatively very strong character which goes to show that in some towns at least shellfish have had an important share in producing and maintaining the prevalence of enteric fever, and although there are difficulties in dealing with some of the evidence adduced, owing to the paucity and relative unreliability of the data available, it may be said generally that the amount of enteric fever attributed by medical officers of health to shellfish is increasing in direct proportion to the amount of attention devoted to the subject and the care which is exercised in the detailed investigation of individual cases or groups of cases. It is well to bear this fact prominently in mind.

It must not necessarily be inferred that the increase above alluded to is in itself evidence that shellfish are producing more enteric fever than heretofore, since in medical matters, as in other branches of investigation, the unconscious influence of fashion or perhaps suggestion cannot be altogether eliminated. But, however, this may be, careful investigation by trained epidemiologists will in the end have the effect of eliminating spurious cases and substituting genuine ones.

As far back as 1894 and in subsequent years Dr. Arthur Newsholme, at that time medical officer of health of Brighton and now Principal Medical Officer of the Local Government

Board, attributed cases of enteric fever in Brighton to the consumption of raw mussels procured from the neighbourhood of a sewer outfall at Shoreham, and in Part IV. of Vol. XVII.* of the Journal of the Sanitary Institute there will be found set out in detail the arguments which induced him to associate together the mussels and the enteric fever in the relation of cause and effect.

In his annual report for the same year, Dr. Newsholme stated that "at least 40 per cent. of the cases of enteric fever originating in Brighton during last year were ascribable to sewage-contaminated shellfish," and in his report for the following year he attributed 30·4 per cent. of the enteric fever as due to the same cause.

The facts constituting the evidence leading to the above conclusion were that in the majority of cases either—

(*a*) the one person taking the shellfish was the one person acquiring typhoid fever, or

(*b*) when other persons in the same house had eaten shellfish they had diarrhœa or other evidence of illness, although this did not develop into actual typhoid fever.

In 1896 the Brighton Corporation made an unsuccessful attempt to obtain by a private bill power to prevent this importation of sewage-contaminated shellfish into the borough.

In his annual report for the year 1899 Dr. Newsholme furnished the following table (to which the year 1900 is added) comprising *inter alia* the number of enteric fever cases which were directly ascribable to shellfish other than oysters—

Year.	No. of cases subsequently found not to be Enteric Fever, or of which the nature was doubtful.	No. of cases of Enteric Fever, the infection of which was imported from other districts.	No. of cases apparently originating in the town in which :—				Infection probably acquired in connection with the storing or handling of shellfish.	Total cases of local origin.
			(*a*) It was stated that no oysters or other shellfish had been eaten.	(*b*) It was doubtful as to whether shellfish had been eaten.	(*c*) Origin was directly ascribable to oysters.	(*d*) Origin was directly ascribable to other shellfish.		
1893 (from Midsummer).	1	16	19	6	6†	—	—	31
1894	15	15	33	1	16	5	—	55
1895	12	19	37	—	7‡	12	—	56
1896	7 + 3	18	61	2	22§	8	1	94
1897	7 + 3	15	47	11	11‡	16	3	88
1898	16	15	54	3	28‖	13	—	98
1899	15	30	56	20	44¶	8	—	128
1900	19	15	28	4	12‡	4	1	49

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* Journal of Sanitary Institute, Vol. xvii., Part iv., 1897, p. 389.

† No secondary cases.

‡ Including one secondary case.

§ Including two secondary cases.

‖ Including five secondary cases.

¶ Including seven secondary cases.

and he stated that the Brighton evidence went to show that of the total number of cases of enteric fever originating in the borough 37·2 per cent. were ascribable to sewage-contaminated oysters or mussels. He also pointed out that enteric fever showed a remarkable diminution during the autumn at a time when the disease is generally most prevalent, and he attributed this decline to the warning notices which were posted in the town in the week following August 16th, and which led to a very great diminution in the consumption of oysters and mussels derived from layings contaminated with sewage.

Further reference to the decline of enteric fever in Brighton will be made in a later chapter.

Dr. James Niven, the medical officer of health of Manchester, has for many years devoted much attention to the subject, and he has gone into it with such detail that the numerous arguments which he adduces in relation to the several phases can only be adequately appreciated by reference to his successive annual reports from 1903 onwards.

It was in 1904 that out of 325 notified cases of enteric fever, 46 gave a history of the consumption of mussels or other shellfish prior to attack, the most common shellfish being mussels eaten raw.

In 1905 out of 345 cases notified, 99 may have been due to shellfish, the incidence of the suspected shellfish cases during the several quarters having been—first quarter 22; second 24; third 12; fourth 41. And Dr. Niven points out that the conditions as regards the mussel season lead to such an influx of mussels in September as to suggest that the high incidence of mussel cases in the fourth quarter may be in part responsible for it.

Dr. Niven has found that certain shellfish shops stand out prominently in relation to enteric fever, a fact which he attributes to their supplies being procured from particular layings on the Welsh and Irish coasts. He concludes that shellfish play a decided part in the causation of enteric fever and other diarrhœal diseases in the city, a statement which is repeated in 1906, during which year 31·0 per cent. of the enteric fever in Manchester was regarded as not improbably due to shellfish.

Dr. Niven's reasons for attributing enteric fever to mussels are thus summarised by him:—

1. From time to time two persons consuming mussels purchased from the same source and at the same time are subsequently attacked by enteric fever.

2. The cases traced to some previous source of personal infection are separate from those traced to shellfish.

3. In 1902 an investigation was made as to the consumption of shellfish in 1,354 houses inhabited chiefly by artisans, and it was found that shellfish had been used at one or another time in the previous year in 384 houses. At 90 houses they had been consumed raw, at 360 cooked; at some they had been consumed both raw and cooked.

It was subsequently* found, however, on inquiry as to the proportion in which raw and cooked mussels respectively had been eaten by cases of enteric fever associated with shellfish that for the years 1903 and 1904 taken together the figures were as follows:—

Raw.	Cooked.	Both Raw and Cooked.
78	16	6

and although, as Dr. Niven observes, large quantities of mussels are consumed outside the home in a raw condition both by young men and women, he regards the complete reversal of the above figures as an argument in favour of the association between mussels and enteric fever. He adduces as further evidence the fact that in a large number of cases it is possible to trace, through the retailers, the wholesale dealers in mussels, and thus in several instances to discover the layings from which the shellfish was procured.

In this way it has been found that there is a tendency for some dealers to be more concerned with enteric fever cases than others, and that in some years cases belonging to the respective dealers have come in rushes, rushes which have not corresponded to one another in point of time.

There is, it seems, a far greater tendency for particular layings to be involved than for particular dealers, and Dr. Niven observes that "one particular mussel, known as 'Conway,' has again and again come under suspicion."

For instance, at the beginning of 1907 a list of 23 shellfish purchases were submitted to the wholesale dealers, and it was found that no fewer than 15 came from Conway. Similarly, Dr. Niven states, that attention, although to a less extent, has been directed to certain other layings in Ireland and off the west coast of England and Wales, and he regards these facts as adding greatly to the probabilities that the relation between shellfish and enteric fever is causative and not merely one of association.

There can be little doubt that this inference, under all these circumstances, is probably sound, but in order to afford it increased weight it would be necessary to ascertain, for instance, what relation this Conway mussel supply to Manchester bore to the total mussel supply of the city. Assuming it to be the most important source of supply, the probability of cases of enteric fever being associated with that rather than other sources of supply would, *ceteris paribus*, be correspondingly great. I have endeavoured to obtain information in the above sense, but have failed. I suspect, however, that this Conway supply is not so great as that coming from all other sources.

Dr. Nash, formerly medical officer of health of Southend and now county medical officer of health of Norfolk, has for many years devoted attention to the question of the relation of shellfish to the prevalence of enteric fever in Southend, and he has had special regard to the influence which cockles, prepared for consumption at Leigh-on-Sea, have exerted on the behaviour of enteric fever in Southend itself and in other places.

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* *See* Annual Report of the Medical Officer of Health of Manchester for the year 1907.

In a special report on the cases of enteric fever which occurred in Southend from June to September, inclusive, of the year 1902, Dr. Nash showed that a factor common to a large number of the cases was the consumption of Leigh cockles, and it was found, moreover, that more than half the total—58 cases—which occurred in the months in question were among the very small section of the inhabitants (not more than 5 per cent.) who habitually ate cockles.

Evidence was also adduced pointing to the conclusion that cases of enteric fever which occurred in certain districts (Shoreditch, Battersea, and the City) of the Metropolis were to be accounted for by the consumption of cockles from Leigh, a view which was shared by the medical officers of health of the Metropolitan boroughs in question.*

In a communication to the Epidemiological Society of London in 1903,† Dr. Nash also brought forward evidence leading to the conclusion that the seasonal curve of enteric fever in Southend and certain other towns could be explained upon an hypothesis that the consumption of shellfish was the dominating factor in inducing such seasonal prevalence.

In a preliminary report upon mussels and enteric fever made to Dr. Robertson, medical officer of health of Birmingham, by Dr. G. F. Buchan, a list of 74 cases of enteric fever which partook of mussels within four weeks of the date of onset, and which occurred in Birmingham during 1905-6-7 and 8 is furnished.

Dr. Buchan furnishes the source of the mussels whenever practicable, and he notes that 62 of the cases occurred during the height of the mussel season, *i.e.*, the end of September and October, November, December, February, and March.

In discussing this question of shellfish-borne enteric fever at the Royal Society of Medicine in May, 1908,‡ Dr. Robertson observed that during the last quarter of the year 1908 over 25 per cent. of the notified cases of enteric fever in Birmingham had a history of having consumed mussels within a fortnight of the commencement of the illness. He referred, too, to a number of persons in Sheffield who developed enteric fever from consuming oysters obtained at Cleethorpes during a holiday.

One of the best worked-out examples of what was probably continuous action of specifically polluted shellfish, is the study of the etiology of enteric fever in Belfast, which was made by my colleague Dr. Darra Mair, in 1907, when he was a member of a Commissioner§ appointed by the Local Government Board of Ireland to inquire into the public health and sanitary administration of the City of Belfast. The records of Belfast showed excessive mortality from enteric and continued fever for many years; that such excess had been high in the seventies, and that although it descended in the early and middle eighties it subsequently attained its former level, at which it remained until the end of the nineties, when, from 1897-1901, it reached a level not hitherto attained. Subsequently, it descended year by year until 1907, when its level reached that attained in the eighties. Thus there was, after an initial high incidence, a fall, a rise, and a subsequent decline.

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* Journal of the Sanitary Institute, Vol. XXIII., Part IV., January, 1903.

† Transactions of Epidemiological Society of London, Vol. XXII. (1902–3).

‡ Proceedings of the Royal Society of Medicine.

§ Report of the Belfast Health Commission to the Local Government Board for Ireland, 1908. [Cd. 4128.] Also Proceedings of the Royal Society of Medicine, Vol. II., No. 7, May, 1909. The etiology of enteric fever in Belfast in relation to water supply, sanitary circumstances, and shellfish.

Local opinion attributed the excessive mortality from this disease either to the insanitary condition of the city or to the pollution of one of the sources of water supply, but a critical examination of all the factors did not support the view that either of these agents was the dominant factor in causation of the malady. Neither was capable of explaining the variations in the incidence of the disease upon different wards of the city or the variations in the enteric fever death-rate which took place from time to time.

It was found that the marked increase of fever which took place in 1897 was coincident in point of time with the breakdown of the sewage "shoot" which formerly carried the sewage some distance away from the extensive cockle beds hereabouts, but which, upon breaking down, much increased their opportunities of becoming specifically contaminated. It became clear, too, that a thesis of this nature explained the peculiar limitation of the Belfast enteric fever to the working-class population, while the grouping of the most conspicuous fever areas corresponded closely with the principal centres in which the shellfish was hawked. It is also claimed for this hypothesis that it may be used to explain the fall in Belfast enteric fever which has taken place within recent years, during which there has been, owing to notices and other action, a large reduction in the consumption of Lough shellfish, while a comparison of the seasonal curve of enteric fever in Manchester, London, and Belfast suggests that in the latter city the seasonal prevalence of this disease shows a correspondence with the seasonal consumption of Belfast Lough shellfish.

Altogether, the presumptive evidence in favour of the Lough shellfish having been the controlling or dominant factor in inducing prevalence of enteric fever in Belfast is extremely strong, notwithstanding the fact that there are certain lacunæ which, owing to the imperfection of the available data, it is impossible to fill in.

Enteric Fever attributed to Shellfish polluted in the Houses of Retail Sellers.

The foregoing instances relate entirely to shellfish which were presumably contaminated on the beds or layings or in storage. But it has undoubtedly to be borne in mind that such shellfish may on occasion be polluted in the wholesale or retail premises in which they are kept prior to consumption. In so far as the retailers are concerned it is important to remember that much shellfish is sold by hawkers with fish barrows, and that such persons are not unlikely to inhabit districts and localities where sanitary imperfections are common and where medical advice is only sought when disease is well developed.

The occurrence of a recognised or unrecognised case of enteric fever in the house of one of these shellfish hawkers might therefore not improbably result in the specific contamination of the shellfish, with consequences similar to those which are believed to have ensued in Merthyr Tydfil in 1903, and which are herewith summarised.

In the autumn of the year 1903 there occurred at Merthyr Tydfil in Wales an extensive outbreak of enteric fever, which was attributed by Dr. D. J. Thomas,* the medical officer of health, to the consumption of cockles and mussels, such shellfish having, in his opinion, become specifically infected not on the beds but during the process of cleaning to which they were subsequently subjected in the house of the salesman.

After eliminating imported and contact cases, there remained 123 cases in the group to which attention was directed; out of this number 84 were found to have partaken of cockles or mussels about 14 days before the onset of the symptoms. This statement refers only to those who could definitely remember to have eaten the shellfish in question, and Dr. Thomas thinks it probable that there were other instances in which the fact of the consumption of shellfish had escaped the memory of the patients and their friends, seeing that in some cases inquiries were delayed until five or six weeks after the attack.

Dr. Thomas points out that these figures are, of course, in no sense conclusive in an industrial district where the workmen are very partial to shellfish, but upon going more minutely into the question it was found that no less than 76 of the persons attacked obtained their shellfish from the same source and on the same date (August 15th), and that 69 of the cases were notified between August 28th and September 6th, there having been 13, 24, and 14 notifications on August 30th and 31st, and on September 1st, respectively.

On September 14th two samples of the suspected cockles and mussels were examined bacteriologically, one from the gathering ground, the other from the house from which they were retailed. Both were regarded as polluted, but Dr. Thomas emphasised the fact that the pollution of the retail sample was much greater than that from the gathering grounds.

As he observes, the bacteriological examination of shellfish collected in September is in no sense conclusive as to the cause of the outbreak. But it appears that on August 15th there was in this retailer's house a source of specific contamination. It was found that the retailer had one consignment of mussels and cockles weekly. The cockles arriving in the "shelled" condition, that is to say, after having been steamed and the shells separated from the soft parts. Cockles thus treated are known as "rython." The process of "cooking" is not, in the view of Dr. Thomas, sufficient to destroy pathogenic bacteria. But, however this may be, it appears that in this instance specific contamination is regarded as having occurred after the arrival of the cockles at Merthyr, where they were cleansed to remove the brine, on the night preceding their sale, by washing them in buckets placed in tubs of water.

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* Annual Report of the Medical Officer of Health of Merthyr Tydfil Urban District for the year 1903.

It seems that a member of this retailer's family had been confined to bed since August 21st with enteric fever, and the history of the case showed that the illness dated from August 12th or 13th, on which latter day a consignment of mussels and cockles arrived. On the following day they underwent the usual process of cleansing, and on the following day, which was a Saturday, they were sold. As a rule, the wife carried out the cleansing process, but on the day in question the person, who was certainly suffering from enteric fever, assisted.

Dr Thomas thus summarises the circumstances:—

1. 76 persons partook of cockles and mussels on August 15th. The shellfish were obtained from one source, and this article of food was the only factor common to all the cases.

2. All the patients exhibited symptoms of typhoid fever within a period of 12-22 days after the consumption.

3. The shellfish were shown to be open to pollution during storage.

4. There was a case of typhoid fever in the house of the retail dealer on August 15th, and the sufferer handled the shellfish.

On these grounds Dr. Thomas regards it to be a justifiable assumption that the source of the infection was the shellfish in question.

The Influence of Infected Shellfish in the Production of Enteric Fever amongst Visitors to Seaside Resorts.

There can be little question that occasionally infected shellfish consumed by visitors at holiday resorts is responsible for some of the enteric fever occurring in our large towns and in other inland places, and a few illustrative cases will be given:—

Dr. Ridley Bailey, medical officer of health of Bilston, in his annual report for 1896 relates an instance in which four persons, who visited Blackpool, and who were seized with symptoms of ptomaine poisoning shortly after consuming raw mussels procured from the vicinity of a sewer outfall, and two of these persons subsequently developed enteric fever under conditions which rendered it probable that the shellfish consumed were the cause of the disease.*

In this connection, it has to be recorded that my colleague, Dr. F. J. H. Coutts, when medical officer of health of Blackpool, drew attention in many of his annual reports to cases of enteric fever caused by mussels taken from Blackpool pier.

In the year 1899 there occurred in the city of Exeter numerous cases of enteric fever amongst children who had attended school treats at Exmouth, and who had partaken of raw cockles either at or derived from that place.

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* *Lancet*, April 10, 1897, p. 1031.

As has already been stated on page 34 the medical officer of health of Exeter found that the sewage of a portion of the lower part of Exmouth had recently been diverted into the brook which formerly took the Withycombe sewage only, and cases of enteric fever had occurred in that part of Exmouth from which the sewage had been diverted. The brook in question discharged over the mud banks from which cockles were collected.

As the result of representations made to the Exmouth Urban District Council, steps were taken to prevent the collection of cockles over the danger zone, and there followed a marked diminution in the number of cases of enteric fever notified in Exeter, which may, however, have been in some degree due to the termination of the holiday period.

Dr. John Robertson, formerly medical officer of health of Sheffield but now medical officer of health of the city of Birmingham, drew attention while at Sheffield to an epidemic of enteric fever amongst persons who had consumed oysters while at Cleethorpes for a holiday, and who upon their return to Sheffield developed enteric fever.†

Dr. F. J. Allan in his annual report for the city of Westminster for the year 1902, in dealing with the prevalence of enteric fever in his district, states that 30 persons were believed to have contracted the disease from eating shellfish, 22 of them being persons in the Strand and Covent Garden Wards who had visited Southend and Southwick, at one or other of which places they had eaten cockles or mussels from sources known to have been sewage polluted. Another of the patients had eaten cockles brought from Southend at stalls in London, while six others had eaten shellfish on a day trip to seaside places on dates which would correspond with the incubation period.

In his annual report for the Clown Rural District for the year 1903, Dr. Walter Spencer, the medical officer of health, stated that on Saturday, July 25th, there was a large colliery trip from Barlborough to Cleethorpes, and within 21 days nine cases of enteric fever were notified amongst the trippers, all who were attacked having eaten freely of oysters at Cleethorpes.

By the end of August—inclusive of the nine cases above referred to—40 cases had been notified, and of this number 26 had partaken of Cleethorpes oysters, mostly at Cleethorpes, but in three instances the shellfish had been brought home from Cleethorpes by friends who had been on the excursion.

Dr. Spencer furnishes two illustrative cases:—

W. G. went to Cleethorpes, together with five other persons from the same house. He had six oysters, and brought home with him 20 more which he ate next day. Fourteen days later he developed enteric fever, and he was the only person who consumed oysters.

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* Annual Report of Dr. John Woodman, Medical Officer of Health for Exeter for the year 1899.

† Proceedings of the Royal Society of Medicine, Vol. II., No. 7, May, 1909.

J. L. went to Cleethorpes, on the same trip, with five friends, he being the only one who took oysters. Fifteen days later he developed enteric fever, while all the others remained well.

Dr. W. T. G. Woodforde, medical officer of health of the Berkshire combined sanitary district, narrates in his annual report for 1898 the case of a lady who, while on a visit to France with some relatives, partook of some oysters at a watering place in Normandy on September 30th—only four or five were eaten; another lady of the party ate one, and a third took a portion of one. It was noticed at the time that "they did not taste quite right." The lady who only tasted part of the oyster did not suffer at all, both the others were attacked with diarrhœa on the following night, and though this passed off, the one who had taken the four or five did not entirely recover from their effects, and on October 10th she was found to be suffering from enteric fever.

Summary.

The evidence brought forward in this chapter shows:—

1. That oysters, mussels, or cockles are at times responsible for isolated cases and groups of cases of enteric fever, of gastro-enteritis, and of mytilotoxine poisoning.

2. That such shellfish have also to be held responsible for extensive outbreaks of enteric fever and gastro-enteritis, and that the amount of mischief in this latter sense has not hitherto been adequately appreciated.

3. That these shellfish have also been shown to have played, and to be still playing, an important part in certain towns in maintenance of enteric fever prevalence.

4. That for the most part the specific contamination of such shellfish takes place on the beds or layings, in the storage ponds, or in the process of "washing," but that occasionally the shellfish may become infected by the retailer.

CHAPTER VII.

Evidence pointing to the conclusion that shellfish which have been "cooked" are less liable to act as disease-disseminators than shellfish from the same source eaten raw.

It must be regarded as being in accordance with expectation that the exposure of shellfish to heat should reduce the chances of such shellfish transmitting diseases dependent upon vegetable organisms, and this general statement will remain true, although it can be shown that the application of heat in the process of "boiling" or "steaming" shellfish is not as a rule sufficiently prolonged or intense to effect the entire sterilisation of the shellfish in question.

A considerable body of evidence indicating the soundness of the above inference could be furnished, but illustrative instances will suffice for the purpose.

In the annual report for 1903, Dr. A. Griffith, medical officer of health of Hove, narrates the following case of enteric fever. The patient, who was the mother of a family, had some mussels, which she boiled for her husband, her children, and herself. All ate them with no bad results except to herself, and she subsequently admitted that she ate a few of the mussels before they were boiled.

Dr. James Barras, medical officer of health for the borough of Govan (Scotland), refers in his annual report for 1903 to the following series of cases:—

In July a family of four persons from Govan went to a west country watering-place for a ten days' holiday. While there they all ate some mussels, and on their return they brought back a supply to their friends. Within the incubation period of the disease, all four members of the family developed enteric fever, of which both father and son died. At about the same time cases of enteric fever arose in Glasgow and Partick which had, it was alleged, followed the consumption of mussels.

The mussels brought home by the Govan family were divided amongst four other families in the town, and in each family only that member who partook of the mussels in the raw condition was attacked by the malady, while the other eight persons in the several families, who took the precaution to boil the mussels for from five to ten minutes, all escaped, and experienced no bad results. Two other persons who ate both cooked and raw mussels were indisposed for several days with diarrhœa, etc.

Dr. Barras regards the outbreak as having been undoubtedly due to the consumption of mussels, and in his opinion the fact that the bacteriologist found mussels and cockles gathered from the foreshore here in question to yield *bacillus coli communis* in almost every instance, and the typhoid fever bacillus in some as amounting to practical proof, more especially as shellfish collected from outside the sewage polluted zone were free from any pathogenic organisms.

Dr. T. G. Styan, medical officer of health of Ramsgate, refers in his annual report for 1906 to the instances of two brothers who on a Whit-Monday went to Pegwell Bay and collected a basket of cockles. "One of the boys, although cautioned against it, ate a number of them raw, and a fortnight later developed enteric fever. His brother refused to do so, but took the rest of the cockles home and had them cooked. Six persons ate them after they were cooked, and none of them became ill."

Dr. Niven, the medical officer of health of Manchester, has made some valuable investigations in this connection. In the year 1902 inquiries were conducted in Manchester relative to the consumption of shellfish, and in connection with this inquiry 1,354 houses inhabited chiefly by artisans were visited. Out of the 1,354 houses it was stated that shellfish had been eaten at one or another time during the previous year by the occupants of 384 houses. In 90 houses the shellfish had been consumed raw, and in 360 cooked, while in some they had been consumed both raw and cooked. Dr. Niven* subsequently ascertained for the years 1903 and 1904 in what proportion raw and cooked mussels respectively had been used by persons who had presumably contracted enteric fever through such shellfish, and it was found that 78 persons had eaten the mussels raw, 16 cooked, and 6 both raw and cooked; in other words the incidence of enteric fever was greatly in excess upon the eaters of raw mussels, whereas on a basis of the 1902 census of mussel eaters the opposite was to have been expected on the assumption that the cooking had exercised no sterilising effect.

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* Annual Report of Dr. Niven for City of Manchester for the year 1907.

Perhaps one of the strongest illustrations of the point here under discussion is that furnished by the historical outbreak of enteric fever which occurred in the autumn of the year 1894 at the Wesleyan College, Connecticut,* and which was investigated by H. W. Conn, Professor of Biology. In this instance there were seven fraternities who sat down to a commemoration supper in the autumn of 1894, and amongst the members of which there were subsequently numerous cases of enteric fever. It was found that practically all the cases were amongst three of the seven fraternities, and it was shown conclusively that this attack was due to the consumption of oysters taken from a specifically polluted laying, and which were eaten raw by the members of the three fraternities concerned. Of the remaining four fraternities none were attacked with enteric fever, although one of the four fraternities had oysters from the same polluted source, the only difference being that in this case the oysters were cooked, whereas the three invaded fraternities consumed the oysters raw.

Dr. George F. Buchan, in a preliminary report made to Dr. Robertson, medical officer of health of Birmingham, upon mussels and enteric fever, states that in two instances in 1907 in which mussels were eaten raw, in one the consumer was sick immediately after eating them, and showed the early symptoms of enteric fever six days later, while the other showed no such symptoms, but developed enteric fever. This patient's wife, who ate a few of the same batch of mussels, but in a cooked condition, was in no way affected.

The actual experience of Southend in the matter of thoroughly boiling cockles has also an important bearing upon this subject. Before the commencement of the shellfish season of 1903, some of the leading cockle merchants, on the advice of Dr. Nash, arranged to procure cockles from purer sources than formerly, and to boil them in clean water in a tank of 140 gallons capacity, the cockles being allowed to actually boil for four minutes. Although several cases of enteric occurred during 1903 in Southend, not one of the cases occurred among persons who obtained cockles thus prepared. Further, during 1904 arrangements were made for the cockles to be subjected to steam for four or five minutes, and Dr. Nash states that practically every cockle merchant in the town adopted this method. In that year no case of enteric fever could be traced to cockles sold by any of the ratepaying cockle vendors in Southend; indeed, during September of that

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[*] Seventeenth Annual Report of the State Board of Health of the State of Connecticut. *See also* Twenty-fourth Annual Report of the Local Government Board.—Supplement in continuation of the Report of the Medical Officer for 1894–95 :—On Oyster Culture in relation to Disease.

year Southend, with a residential population of 42,000, and a large influx of visitors, furnished not a single case of enteric fever.

It is not, of course, suggested for a moment that a large number of persons who eat "cooked" shellfish do not contract enteric fever therefrom, but the evidence adduced, coupled with the fact that it has been experimentally shown by Dr. Klein* that the boiling of cockles for the space of some five minutes renders them practically sterile suffices to show that it is safer to eat partially cooked rather than raw shellfish, and that by the simple process of thoroughly cooking such articles of diet, even shellfish procured from polluted sources may be consumed with relative impunity, provided, of course, that they are not, as has sometimes happened, re-infected by being washed in polluted water after cooking, or exposed to infection in some other fashion.

The transference of uncooked or imperfectly cooked Shellfish to the thoroughly cooked food class of diet.

There seems need for a better appreciation on the part of the public of the fact that some risk must attend the consumption of all raw foods, whether vegetable or animal.

As regards vegetable foods eaten raw or uncooked, mention may be made of watercress, which are not infrequently collected from sources liable to sewage contamination, and washed in water sometimes similarly liable, as well as of lettuces, mustard and cress, cabbage, celery, horse-radish, strawberries, and radishes, all of which latter, being in contact with the earth, are liable to be contaminated by manure, while fruits, such as blackberries, raspberries, gooseberries, plums, etc., which grow at some elevation from the ground, are only liable to contamination by the employment of dirty hands in the process of gathering, and by infected dust or dirt after collection. In the case of many fruits, however, the risk of infection is reduced by the practice of peeling them prior to consumption.

With respect to animal foods, the only one of material consequence, other than shellfish, which is consumed raw, is milk, which, as everyone is aware, is frequently responsible for outbreaks of enteric fever, and doubtless to some extent for the introduction of bovine tuberculosis into the animal economy. By careful boiling, however, risks in the above sense can be avoided.

It is a curious circumstance that the only animals eaten raw and actually living are certain shellfish such as oysters, mussels and cockles; or rather the only shellfish which is as a matter of custom almost invariably eaten quite raw is the oyster. Other "shellfish," such as lobsters, crabs, and shrimps, are always well boiled before consumption, and although these crustaceans are sometimes caught or stored in polluted localities, there is no sufficient evidence to involve them as having been responsible for outbreaks of enteric fever, although, of course, numerous persons have within three weeks of the consumption of these articles of food developed enteric fever.

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* Report of experiments and observations on the vitality of the bacillus of typhoid fever and of sewage microbes in oysters and other shellfish. Investigations on behalf of the Worshipful Company of Fishmongers, London, by E. Klein, M.D., F.R.S. Published by the Fishmongers Company, 1905.

As instances of fish proper (*pisces*) which are often captured in polluted estuaries, salmon, whitebait, and smelts may be noted, but the fact that these fish are invariably boiled has apparently prevented them from acting as disease carriers, although it is not improbable that entire sterilisation of these fish may not always be secured.*

Dr. Hamer has, however, shown that in the case of certain fried fish the treatment to which they are subjected during the frying process is insufficient to thoroughly sterilise them, or that they may in some way or other have subsequently become specifically polluted so as to enable them to act as carriers of enteric fever.

The conclusion appears to be obvious that if consumers wish to protect themselves, so far as practicable, against food-borne diseases caused by micro-organisms they must desist from consuming in a raw state such foods as are liable to become specifically contaminated. Otherwise they must rest content to accept the risks as are likely to accrue after all the precautions which are reasonably practicable have been taken, and, as will be gathered from this report, such risks in the case of shellfish eaten other than thoroughly cooked are likely to remain material.

CHAPTER VIII.

The part believed to have been played in reduction of Enteric Fever prevalence in Certain Towns by limitation of the consumption of Shellfish.

The question as to the precise part played by one or another of the numerous causes which are generally held to be operative in promoting the prevalence of enteric fever in different localities is an impossible problem to solve in the absence of the several data necessary for a critical study of the problem in each particular locality. In so far therefore as the influence of shellfish is concerned, the best course to adopt, although it will involve some repetition, is to epitomise the opinions expressed or the conclusions arrived at by medical officers of health, since such opinions and conclusions, based as they are upon an intimate knowledge of all the local facts and circumstances, must be held to carry great weight.

Consequently it is proposed to deal, in the first place, with certain towns in which detailed attention has been paid by the medical officers of health to the question of shellfish influence, where definite conclusions have been arrived at as to such influence, or where decisive steps have been taken to limit the consumption of shellfish.

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* Certain experiments recently carried out at Birmingham by Dr. G. F. Buchan point to the conclusion that the complete sterilisation of mussels is not brought about even after prolonged boiling either in water or in steam, and, on the other hand, experimental work carried out by other observers show the great difficulty which obtains in procuring shellfish either naturally or culturally which are not in some measure carriers of organisms associated with animal excreta.

So far as practicable, tables will be furnished showing the behaviour in consecutive years of enteric fever in the towns under consideration, and such tables will, for the most part, represent the enteric fever death-rate per 100,000 of the population.

Having considered the case of towns where the shellfish question has been prominent, attention will be directed to the case of certain large towns where, until quite recently, very little, if any, enteric fever has been attributed to shellfish, and where, consequently, less public notice has been attracted to the matter.

DIVISION I.

The towns dealt with in this first section are:—

- Brighton.
- Exeter.
- Grimsby.
- Ipswich.
- Manchester.
- Portsmouth.
- Southampton.
- Southend.
- Winchester.
- Yarmouth (Great).
- Belfast.

Brighton.

(Population (1909) 130,926.)

In Chapter VI. attention has been called to Dr. Newsholme's observations at Brighton relative to shellfish-borne enteric fever, and it is only necessary to refer here to the following table showing enteric fever death-rate per 100,000 population in Brighton since notification came into force:—

Year.	No. of Deaths per 100,000 population.	Year.	No. of Deaths per 100.000 population.	Year.	No. of Deaths per 100.000 population.
1892	7	1898... ...	15	1904... ...	5·5
1893	13	1899* ...	20	1905... ...	1·6
1894	9	1900... ...	10	1906... ...	2·3
1895	12	1901... ...	5	1907... ...	2·3
1896	12	1902... ...	11	1908... ...	3·9
1897	17	1903... ...	3	1909... ...	4·6

* Posters exhibited.

(Census population (1891) 115,873; (1901) 123,478.)

The fact is emphasised that it was not until August 16th, 1899, that the warning posters which have since been continuously displayed in Brighton were exhibited, and although attention has been called from 1894 onwards to the importance of shellfish as a cause of enteric fever, it was not until 1899 that the first effective blow was dealt against the evil. The result, Dr. Newsholme points out, is shown in the diminished death-rate from enteric fever.

As regards London a similar course has, he observes, been followed, and this he also attributes largely to the fact that the public have learnt to regard shellfish as a very suspicious source of food, and have either abstained from it altogether or been extremely careful in their choice of shellfish from sources known not to be contaminated. Brighton has, he adds, benefited more than London by the change in circumstances, which he regards as probably due to the fact that more energetic steps were taken in Brighton, and that a small community is more easily influenced than a large community.

Exeter.

(Population (1909) 48,798.)

In his annual report for the year 1902 Dr. Woodman, then medical officer of health, in connection with the circumstance that the notified cases of enteric fever for that year were the lowest on record, observes that: "In looking for the cause of this very marked decline one is again brought to believe that shellfish contamination must have played a very important part as the cause of typhoid in the city, and especially when, in reviewing past events, we find that the rise and fall of this disease in the city corresponds almost identically with the times when sewage was discharged in the vicinity of the cockle beds, and when it was removed from the vicinity of the cockle beds of which we had to complain."

The number of cases notified within the last twenty years has been as follows:—

Year.	Cases.	Year.	Cases.	Year.	Cases.
1890... ...	39	1897... ...	96	1904... ...	30
1891... ...	48	1898... ...	93	1905... ...	20
1892... ...	47	1899* ...	186	1906... ...	37
1893... ...	57	1900... ...	91	1907... ...	18
1894... ...	56	1901... ...	41	1908... ...	17
1895... ...	58	1902... ...	33	1909... ...	48†
1896... ...	74	1903... ...	31		

(Census population (1891) 45,766; (1901) 47,185.)

Death-rate from "Fever" per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.
1894... ...	19	1900... ...	40	1905... ...	6
1895... ...	24	1901... ...	13	1906... ...	10
1896... ...	35	1902... ...	6	1907... ...	4
1897... ...	45	1903... ...	2	1908... ...	0
1898... ...	19	1904... ...	8	1909... ...	2
1899* ...	48				

* Year of outbreak in connection with Exmouth cockles.
† Increase due to milk-borne outbreak.

Sources of Shellfish.

Mussels.—Lympstone, Starcross.

Cockles.—Starcross, the Exe generally.

The cockle trade, which continues during the whole year, has decreased very much since the enteric fever "scare" of 1899 and 1900, and Dr. Brash, the Exeter medical officer of health, draws attention to the subsequent fall in the enteric fever incidence.

Grimsby.

(Population (1909) 73,036.)

The attention which has been called to Grimsby as the source, through its shellfish, both of cholera and enteric fever, necessitates a few comments in the present report.

At one time (*see* "Oyster Culture in Relation to Disease") there were extensive oyster layings off Grimsby in the mouth of the Humber, and in the report "On Cholera in England in 1893," which the late Sir Richard Thorne-Thorne, at that time Principal Medical Officer of the Local Government Board, submitted to the Board in 1894, the opinion was expressed that the distribution of shellfish from Cleethorpes and Grimsby had been concerned in the diffusion of scattered cases of cholera in England. As will be seen by the report on oyster culture, the oyster layings hereabouts were then in a position in which their pollution by the sewage of Grimsby and Cleethorpes was seriously threatened.

These layings were, however, removed to Hunstanton in 1904, and Dr. W. Bulmer Simpson, the medical officer of health of Grimsby informs me that there have not for a number of years been any "layings" on beds in his district for depositing shellfish pending their distribution, the shellfish coming into Grimsby from the North Sea and other sources being now stored at Hunstanton until required for distribution.

He adds that there have not to his knowledge been any definite outbreaks of enteric fever in Grimsby, traceable to shellfish, in late years. Occasionally sporadic cases have been noted in which it appeared probable that the eating of shellfish had been the means by which the specific organism had been introduced, but no definite or well-defined "outbreak" had been recorded.

Dr. Simpson observes that "where so many possible causes are in operation it is difficult to say how far one cause or another has been the *fons et origo mali* in any particular case."

Death-rate from "Fever" per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1894 ...	48	1898 ...	40	1902 ...	43	1906 ...	14
1895 ...	40	1899 ...	40	1903 ...	29	1907 ...	21
1896 ...	28	1900 ...	21	1904* ...	19	1908 ...	19
1897 ...	18	1901 ...	55	1905 ...	16	1909 ...	25

* Shellfish beds removed to Hunstanton.

(Census population (1891) 51,934; (1901) 63,138.)

Present Sources of Grimsby Shellfish.

Oysters.—Holland, America, Hunstanton, Saltash.
Mussels.—Holland, Hunstanton.
Cockles.—Grainthorpe, Hunstanton.

Dr. Simpson calls attention to the fact, which is obviously of some importance, that an inconsiderable number of shellfish of various kinds may be picked up on the shore between Grimsby and the mouth of the Humber, but not in such quantity as to come upon the market.

Ipswich.

(Population (1909) 74,889.)

Since the year 1902 the attention of the people of Ipswich has been prominently drawn to the danger of consuming cockles collected from the foreshores of the Orwell estuary.

The subject was first referred to by Dr. G. S. Elliston, the then medical officer of health, in the summer of 1902, and in his annual report for that year, as well as in the reports for 1904 and 1905, great emphasis was laid upon the part played by cockles in causation of cases of enteric fever in Ipswich. In his annual reports for 1906-1908 Dr. Pringle, the present medical officer of health, refers in detail to the same subject, and in the latter year Dr. Cooper Pattin, medical officer of health of Norwich, attributed an outburst of enteric fever in that city to cockles which were alleged to have been imported from Ipswich. Similarly, cockles said to have been derived from this source were held responsible by the medical officer of health of Lowestoft for at least one case of enteric fever in that town in 1908.

A detailed account of the evidence as regards Ipswich will be found on pages 164 to 170, and an instructive paper on the subject by Dr. Pringle is given in " Public Health " for August, 1909.

Notifications of Enteric Fever in Ipswich.

Year.	Cases.	Year.	Cases.	Year.	Cases.	Year.	Cases.
1890 ...	35	1895 ...	86	1900 ...	92	1905 ...	*50*
1891 ...	77	1896 ...	57	1901 ...	62	1906 ...	*36*
1892 ...	45	1897 ...	55	*1902 ...	*173*	1907 ...	*33*
1893 ...	134	1898 ...	67	1903 ...	*45*	1908 ...	*15*
1894 ...	41	1899 ...	284	1904 ...	*50*	1909 ...	*15*

* Subject of shellfish first drawn attention to.

(Census population (1891) 57,433; (1901) 66,630.)

Cases attributed year by year to Shellfish.

Year.	Number of cases notified.	Number due to cockles.	Percentage of cockle cases.
1902	173	35	20
1903	45	5	11
1904	50	2	4
1905	50	9	18
1906	33	7	21
1907	33	9	27
1908	15	7	46
1909	15	2	13

Dr. Pringle evidently attributes the greater share in the diminution of enteric fever in Ipswich to the different method of dealing with the sewage of the borough. Prior to 1894 the privy-midden system obtained, and at that time there were, as will be seen below, more than 8,000 privies in the town, while in 1909 there were not more than 96.

The following table shows, *inter alia*, the conversion from privies to water-closets which took place year by year since 1890:—

Year	Number of Middens.	Cases of Enteric Fever notified.	Attack-rate per 1,000 living.	Death-rate from "Fever" per 100,000.
1890	8,000 and over	35	0·60	14
1891	8,000 and over	77	1·34	28
1892	8,000 and over	45	0·77	12
1893	8,000 and over	134	2·27	33
1894	7,802	41	0·68	6
1895	7,506	86	1·41	18
1896	6,952	57	0·92	12
1897	6,382	55	0·87	9
1898	5,815	67	1·05	10
1899	5,013	284	4·38	49
1900	4,014	92	1·40	18
1901	2,857	62	0·93	21
1902	2,104	173*	2·35	47
1903	1,336	45	0·65	8
1904	728	50	0·71	10
1905	229	50	0·70	9
1906	150	33	0·50	5
1907	140	33	0·46	4
1908	110	15	0·20	1
1909	96	15	0·20	4

* Subject of shellfish drawn attention to.

It has also to be noted that up to the year 1902 more than 50 per cent. of the enteric fever cases were treated at home, whereas within recent years over 80 per cent. of the cases have been isolated in the fever hospital.

Although Dr. Pringle has no doubt but that the privy middens were largely responsible for the prevalence of enteric fever in Ipswich in the past, he brings out clearly the important share taken by shellfish in enteric fever causation (*see* page 164), and he is emphatic as to the necessity for putting an end to the consumption of molluscs gathered from unwholesome areas.

Manchester.

(Population (1909) 655,435.)

Dr. James Niven has for several years past drawn attention to this question in his annual reports for this city, and he has made valuable contributions to the subject. It may therefore be inferred that the public of Manchester have had their attention to some extent called to the danger of consuming raw shellfish.

Reference is made elsewhere to Dr. Niven's remarks as regards enteric fever and shellfish, and as to the share which they have in maintenance of enteric fever in Manchester.

Enteric Fever Notifications.

Year.	Cases.	Year.	Cases.	Year	Cases.	Year.	Cases.
1891 ...	761	1896 ...	513	1901 ...	359	1906 ...	384
1892 ...	610	1897 ...	503	1902 ...	378	1907 ...	265
1893 ...	618	1898 ...	642	1903 ...	387	1908 ...	393
1894 ...	460	1899 ...	381	1904 ...	325	1909 ...	369
1895 ...	493	1900 ...	378	1905 ...	345		

(Census population (1891) 505,368; (1901) 543,872.)

Death-rate per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1883 ...	20	1890 ...	27	1897 ...	18	1904 ...	12
1884 ...	19	1891 ...	37	1898 ...	22	1905 ...	9
1885 ...	17	1892 ...	24	1899 ...	13	1906 ...	14
1886 ...	29	1893 ...	25	1900 ...	14	1907 ...	6
1887 ...	31	1894 ...	17	1901 ...	14	1908 ...	11
1888 ...	33	1895 ...	18	1902 ...	12	1909 ...	13
1889 ...	31	1896 ...	22	1903 ...	17		

Sources of Shellfish.

The following list is taken from the evidence furnished by Dr. Niven to the Royal Commission on Sewage Disposal in 1903:—

Relaid Oysters.—Brightlingsea, Cleethorpes, Fleetwood, Beaumaris; Londonderry, Warrenpoint, Carlingford, Malahide; Sutton.

"*Native Oysters.*"—American, Dutch, Portuguese, Whit stable, Colchester, Dublin.

Mussels.—Morecambe, Glasson Dock, Fleetwood, Askam, Cark, Ulverston—Lancashire; Lynn—Norfolk; Boston—Lincs.; Lympstone—The Exe; Hoylake, Connah's Quay, West Kirby, Parkgate, Neston, Flint—The Dee; Conway, Barmouth, Aberdovey—Wales; Kircudbright, Creetown—Solway Firth; Londonderry, Belfast, Dundalk, Omeath, Warrenpoint, Carlingford, Drogheda, Cork, Killorglin—Ireland.

Cockles.—Askam, Ulverston, Cark, Lytham, Parkgate, Boston, Lynn, Borve; Aber—Wales.

Dr. Niven, in his annual report for 1903 (p. 128), furnished a list of 52 cases of enteric fever in which shellfish had been consumed from one day to a month antecedent to attack. This number amounted to 13 per cent. of the total attacks. In 28 cases the shellfish were eaten raw, in 17 cooked, and in 7 both raw and cooked. The interesting fact is brought out that in 21 instances the patient partook of this shellfish in company with friends, but in all instances, with one exception, all these friends remained well.

As Dr. Niven observed, the incubation period in several of the cases is very short, but the cases are apparently included because the patients suffered from gastro-enteritis shortly after the shellfish was eaten.

In the year 1904 there were 325 cases of enteric fever notified and of this number 41 may have contracted the disease from shellfish as follows:—mussels alone, 30; mussels and oysters, 4; oysters alone, 7. Of this number 28 were males. As to the source of the mussels, Dr. Niven says that Conway mussels have come under suspicion in previous years, and that Neston and Parkgate (on the Dee) are not above suspicion " Drogheda require investigation. Belfast mussels may be regarded as doubtful. Dutch mussels have a doubtful reputation."

In 1905, out of 292 indigenous cases, 95 may have been due to shellfish as shown below:—

——	Cases traced to previous attacks.	? Shellfish.	Not traced.	Total.
First quarter... ...	48	22	21	91
Second "	34	24	13	71
Third "	16	9	10	35
Fourth "	32	40	23	95
Totals... ...	130	95	67	292
Percentage ...	44·5	32·5	22·9	—

In 1906 Dr. Niven regarded 41·1 per cent. of the enteric fever occurring during the first quarter, 51·7 per cent. in the second quarter, 24·6 in the third quarter, and 23·7 in the fourth, as probably due to shellfish, and he makes the statement that from enquiries, made in 1906 taken in conjunction with those recorded in 1905 " it would appear that the main source of enteric fever in this city is shellfish." But it is to be inferred that the experience of 1907 rather modified Dr. Niven's previous opinion since he was unable, as the result of a most careful analysis of the cases for several years past, to ascribe any great influence to shellfish as determining or modifying the period of the seasonal prevalence of enteric fever. But as to this, reference should be made to the original reports.*

Portsmouth.

(Population (1909) 214,726.)

As regards enteric fever in Portsmouth, Dr. Mearns Fraser, the medical officer of health, in his Annual Report for the year 1907, states that out of 233 cases of enteric fever notified, 80, or 34 per cent., contracted the disease from shellfish, and with regard to this he adds, " It is extremely disappointing to find that although year after year public notices have been issued in the shape of handbills, and announcements in the local press, warning the public of the danger of eating shellfish from contaminated sources, so many cases should be attributed to this cause. Oysters, cockles, butterfish, and mussels are continuously picked up from polluted sources round about Portsmouth and consumed with total disregard to the ill-effects that are certain to ensue.

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* *See also* paper " On Summer Diarrhœa and Enteric Fever " read by Dr. Niven before the Epidemiological Section of the Royal Society of Medicine, April 7, 1910. Proceedings of the Royal Society of Medicine, Vol. III., No. 6.

In the year 1908 there were 207 cases of enteric fever, and out of this total 47, or 23 per cent. were ascribed to the consumption to shellfish from polluted areas. Amongst the suspected shellfish were cockles in 28 cases, butterfish in 5, and oysters in 5.

In 1909, out of 274 cases notified it was found that 90 had eaten shellfish within the time that corresponded to the incubation period of the disease.

Dr. Fraser adds that a large proportion of the cockles which are hawked in the town are collected from the sewage polluted mud in the neighbourhood, and he observed that in Portsmouth the public " have been warned time and again of the danger, yet year after year, on making enquiries, I find that a large percentage of the cases have almost certainly arisen from this source. Take, for instance, the mud off Fort Cumberland. This bank is within 300 yards of the main sewer of the borough: it is also a favourite hunting ground for mussels and cockles. Many people have already contracted enteric fever, and a number have lost their lives from eating shellfish collected here."

He points out, too, that although public notices have been issued, attention drawn to the subject in his annual reports, and letters published in the local press, shellfish are still collected there.

Dr. Fraser remarks, however, that during the last six years there have been in Portsmouth considerably fewer cases of enteric fever than formerly, and, as will be seen by the table below, the attack rate in 1908 was only 98 per 100,000, a rate which was only excelled in 1905 and 1906 when the corresponding rates were 81 and 71, respectively. In 1909 the attack rate was 127 per 100,000.

Attack-rate of Enteric Fever per 100,000 *Population.*

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1884	392	1889	207	1894	119	1898	170	1902	233	1906	71
1885	542	1890	292	1895	151	1899	290	1903	111	1907	111
1886	870	1891	165	1896	135	1900	583	1904	113	1908	98
1887	378	1892	203	1897	181	1901	171	1905	81	1909	127
1888	208	1893	218								

(Census of population (1891) 159,278; (1901) 188,135.)

" *Fever* " *Death-rate per* 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1892 ...	26	1896 ...	15	1900 ...	47	1904 ...	17	1908 ...	12
1893 ...	31	1897 ...	24	1901 ...	22	1905 ...	9	1909 ...	15
1894 ...	16	1898 ...	23	1902 ...	28	1906 ...	8		
1895 ...	20	1999 ...	40	1903 ...	12	1907 ...	14		

Sources of Shellfish.

Mussels.—Langstone Harbour, Fort Cumberland.

Cockles.—Langstone Harbour, Emsworth, Fareham, Milton, and other places. Sources largely unknown.

Southampton.

(Population (1909) 124,667.)

In the borough of Southampton there has been, as will be seen by the subjoined figures, a marked decline in the prevalence of enteric fever since the year 1903, and in answer to enquiries made by me from Dr. Lauder, the medical officer of health, as to the cause or causes which may have brought about this diminution, he points out that such decrease is synchronous with the issue of notices warning the public of the risk which is entailed by eating shellfish procured from the polluted Itchen estuary and stating that proceedings would be taken against dealers for exposing such shellfish for sale. The notices also draw attention to the danger of bathing in the Itchen.

Communications were also sent in the autumn of 1903 to the Chief Constable and Secretary of the Education Committee urging them to prevent persons from collecting shellfish, or from bathing or wading in the estuary.

Dr. Lauder adds that he is unaware of any other reason which might be held to account for the decline of enteric fever in the borough.

It may be noted that it was in the winter of the year 1902 that the remarkable outbreak of enteric fever and gastro-enteritis occurred after the Mayoral banquet at Southampton and Winchester, and which were traced to the consumption of contaminated oysters obtained from Emsworth, and the publicity then drawn to the subject is likely to have deterred persons from consuming shellfish.

Year.	Cases.	Year.	Cases.	Year.	Cases.	Year.	Cases.
1890 ...	48	1895 ...	58	1900 ...	73	1905 ...	34
1891 ...	62	1896 ...	79	1901 ...	106	1906 ...	15
1892 ...	82	1897 ...	66	1902* ...	123	1907 ...	21
1893 ...	115	1898 ...	165	1903 ...	148	1908 ...	37
1894 ...	78	1899 ...	173	1904 ...	19	1909 ...	53

(Census population (1891) 82,126; (1901) 104,824.)

"Fever" Death-rate per 100,000 *Population.*

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1894 ...	18	1898 ...	27	1902* ...	17	1906 ...	5
1895 ...	15	1899 ...	20	1903 ...	18	1907 ...	4
1896 ...	15	1900 ...	16	1904 ...	2	1908 ...	4
1897 ...	7	1901 ...	10	1905 ...	9	1909 ...	10

* Date of Mayoral banquet in connection with which outbreak of oyster-borne enteric fever and gastro-enteritis occurred. Warning notices were issued in 1903.

Sources of Shellfish.

Oysters.—Emsworth, France, New York, Warsash, Whitstable, Holland, Calshot, Cowes.

Mussels.—River Itchen, Holland, Hayling, Billingsgate.

Cockles.—River Itchen, Southampton Water, North Hayling, Lymington, Poole, Lynn, Bristol (pickled).

Southend.

(Population (1909) 61,268.)

Reference has already been made to the work done by Dr. Nash, formerly medical officer of health of Southend, as to the part played by shellfish in the causation and maintenance of enteric fever in that borough, and the table below has been furnished by Dr. Pugh, the present medical officer of health, which shows the manner in which enteric fever has declined in Southend. I have converted the death-rates per 1,000 into rates per 100,000 for purposes of uniformity.

Typhoid Fever.

Year.	Number of notifications excluding those subsequently withdrawn.	Imported.	Indigenous.	Possibly due to shellfish.	Indigenous cases per 1,000 population.	Number of deaths.	Deaths per 100,000 population.	Medical Officer of Health.
1892 ...	68 (?)	5	63(?)	?	—	—	38(?)	
1893 ...	136	4	132	?	9·7	16	118	G. F. Jones.
1894 ...	113	—	113	?	7·3	12	78	"
1895 ...	95	6	89	2	5·4	8	49	A. C. Waters.
1896 ...	90	4	86	—	4·9	9	51	"
1897 ...	69	6	63	1	3·26	14	72	"
1898 ...	105	10	95	12	5·4	15+1*	71	"
1899 ...	57	5	52	1	2·3	6	24	"
1900 ...	56	1	55	25	2·0	6	22	"
1901 ...	49	6	43	21	1·5	8+2*	27	J. T. Nash.
1902 ...	105	4	101	72	3·0	12	37	"
1903 ...	66	4	62	56	1·6	10	27	"
1904 ...	15	6	9	10	·23	2	4	"
1905 ...	20	2	18	8	·34	8	17	"
1906 ...	17	—	17	7	·29	2	4	"
1907 ...	19	—	19	10	·35	5	9	"
1908 ...	26	6	20	15	·348	3	5	C. Grant Pugh.
1909 ...	2	1	1	—	·016	–	—	

* Imported.

(Population (1891) 13,242; (1901) 28,857.)

Sources of Shellfish.

Oysters.—Whitstable, Burnham, Mersea Island, Brightlingsea, Leigh Bay (until recently).

Mussels.—Dutch mussels viâ Billingsgate.

Cockles.—Maplin Sands, Marsh End, North shore of Kent.

Winchester.

(Population (1909) 21,423.)

As the city of Winchester was the scene of a remarkable oyster-borne outbreak of enteric fever and other illness after the Mayoral banquet held on December 10th, 1902, and, as the impression produced by this disaster, was very great both in Winchester and elsewhere, I have endeavoured to ascertain how far the abstention from shellfish which may reasonably be supposed to have followed that event locally, has been followed by decline in the prevalence of enteric fever. The annual notifications have been as follows:—

Year.	Notifications of Enteric Fever.	Year.	Notifications of Enteric Fever.	Year.	Notifications of Enteric Fever.
1890	3	1897... ...	2	1904... ...	10
1891	2	1898... ...	3	1905... ...	9
1892	2	1899... ...	3	1906... ...	5
1893	16	1900... ...	2	1907... ...	9
1894	3	1901... ...	18	1908... ...	5
1895	2	(1902)* ...	19	1909... ...	3
1896	1	1903... ...	13		

* Year of outbreak.

(Census population (1891) 20,563; (1901) 20,929.)

Yarmouth (Great).

(Population (1909) 53,430.)

In his annual report for 1899, Dr. Bately, at that time medical officer of health, attributed an uncertain amount of enteric fever to the consumption of mussels, and he was evidently inclined to credit the reduction in the number of notifications in that year to the warning notices which had been issued relative to the danger of consuming mussels. He added, too, "It is interesting to note that a considerable reduction in the typhoid notifications and deaths took place last year in Norwich. The suppression of mussel dredging in Yarmouth has most probably had a wider influence for good than is generally recognised."

In the following year (1900) when there were 123 cases of enteric fever, the then medical officer of health, Dr. Russell, stated that shellfish as a cause could practically be eliminated, as inquiries made at the patients' houses showed that in not one instance had shellfish been recently consumed. In 1901 (87 cases) no reference is made to shellfish, and in 1902 (38 cases) the medical officer of health ascribes the fall in cases to "the various sanitary improvements" carried out in recent years.

In 1903 (28 cases) the present medical officer of health (Dr. Beach) stated that 4 cases illustrated the risk run by eating mussels dredged from the river. In 1904 10 cases out of 64 may have been infected from shellfish, and in 7 of the cases the shellfish had been exposed to pollution, and in his annual report for the year, Dr. Beach ascribes the diminution of enteric fever in Yarmouth as due largely to the notices issued by Dr. Bateley. In 1905 9 cases out of 38 gave a history of the consumption of mussels, and Dr. Beach adds that there can be no doubt as to the source of infection.

In 1906 there were 17 out of 45 cases attributed to mussels, and Dr. Beach stated that although warning notices had been posted about the town, nothing short of the total prohibition of dredging for mussels in the Haven and in Breydon would be of any effect. At present dredging is permitted for bait only, but “ there can be no doubt that some of this bait finds its way into the hawkers' baskets with disastrous results to those who are not immune to the effects of eating food befouled with sewage.”

In 1907, 12 out of 37 cases may have been due to mussels:—

Year.	Cases.	Year.	Cases.	Year.	Cases.	Year.	Cases.	Shell-fish.
1895 ...	150	1898 ...	244	1901 ...	87	1904 ...	64	10
1896 ...	127	1899* ...	131	1902 ...	38	1905 ...	38	9
1897 ...	131	1900 ...	130	1903 ...	28 (4)	1906 ...	45	17
						1907 ...	37	12
						1908 ...	35	10
						1909 ...	35	Nil

* Warnings issued.

The shellfish cases, referred to in this table, in 1903 have been taken from a list kindly furnished to me by Dr. Beach.

(Census population (1891) 49,334; (1901) 51,316.)

“ *Fever* ” *Death-rate per* 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1894 ...	20	1898 ...	88	1902 ...	13	1906 ...	13
1895 ...	22	1899* ...	50	1903 ...	12	1907 ...	9
1896 ...	33	1900 ...	25	1904 ...	10	1908 ...	9
1897 ...	35	1901 ...	23	1905 ...	11	1909 ...	0

* Warnings issued.

Belfast.

(Population (1909) 386,576.)

Reference has been made in Chapter VI. to the behaviour of enteric fever in Belfast, and to the evidence which exists in support of the view that the consumption of shellfish from Belfast Lough is the best explanation of such behaviour, and the subjoined table indicates the course of the disease in so far as the death-rate is concerned from 1872-1909. It will be seen that the death-rate, relative to that of most of the other towns dealt with, is enormous.

It will be seen that from 1889 to 1901 the death-rate except in 1892-3 was always up to or in excess of 50 per 100,000, and that in the year 1898 it reached the phenomenal figure of 200 per 100,000. It will also be noted that notwithstanding the enormous fall which has taken place since 1903, the rate in 1908 amounted to 15 per 100,000, which was still considerably in excess of existing rates in most of the English towns for which tables are furnished in this chapter. In that year, however, Grimsby, Bolton, Preston, Rhondda and Salford all yielded higher rates. But in 1909 the Belfast rate fell to a level materially below the majority of the English large towns.

Death-rate per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1872 ...	79	1882 ...	51	1892 ...	40	1902* ...	46
1873 ...	69	1883 ...	37	1893 ...	43	1903 ...	39
1874 ...	68	1884 ...	29	1894 ...	54	1904 ...	31
1875 ...	58	1885 ...	28	1895 ...	62	1905 ...	35
1876 ...	55	1886 ...	44	1896 ...	50	1906 ...	25
1877 ...	61	1887 ...	39	1897 ...	119	1907 ...	22
1878 ...	63	1888 ...	40	1898 ...	193	1908 ...	15
1879 ...	62	1889 ...	87	1899 ...	81	1909 ...	5
1880 ...	70	1890 ...	67	1900 ...	77		
1881 ...	46	1891 ...	54	1901 ...	100		

* Notices exhibited.

The outstanding features characterising this Belfast table, in relation to the consumption of polluted shellfish, are as follows:—

1. The high death-rate over the whole period;
2. The increased death-rate for 1889-1896 when a new sewerage system was being constructed, and when additional sewage was being delivered in the neighbourhood of the shellfish beds;
3. The enormous rise in the death-rate which occurred in 1897 and in subsequent years when the sewage "shoot" broke down and delivered the sewage still nearer to the shellfish beds; and
4. The marked decline which has taken place in the disease since 1902, when notices warning the public of the danger of shellfish eating were exhibited, and the acceleration of such decline since 1905, when more active steps in the prevention of shellfish eating were undertaken.

DIVISION II.

Consideration of certain Towns wherein less public attention has been directed to the Shellfish question than in those already dealt with.

It will be useful now to take the case of certain towns where the shellfish problem has not until quite recently assumed great proportions or prominence, and where, presumably, the direct steps taken in limitation or control of shellfish have, if any, fallen materially short of the action taken at such places as Brighton and Southend.

The towns here dealt with are as follows:—

Birmingham,
Bolton,
Bristol,
Cardiff,
Derby,
Halifax,
Hull,
Leeds,
Leicester,
Liverpool,
Newcastle-on-Tyne,
Nottingham,
Plymouth,
Preston,
Rhondda,
Salford,
Sheffield,
Sunderland,
St. Helens,
Swansea,
Yorks.

Birmingham.

(Population (1909) 563,629.)[*]

Attention was drawn by Dr. John Robertson, medical officer of health of Birmingham, in his annual report for the year 1907, to the part which during recent years mussels had apparently played in causation of enteric fever in that city, and, as regards the year 1907, he adds:—

"The most important group of cases is that in which there was, prior to the illness, a history of having eaten mussels, oysters, or watercress. Twenty-six patients gave a history of having eaten one or other of these articles within a month of the commencement of symptoms of typhoid fever. In no less than 24 cases mussels were involved. Doubtless, the number of patients who owed their attacks of typhoid fever to mussels was more numerous than the above figures indicate."

Dr. Robertson adds that the evidence has been so strong during the past few years as to the incidence of typhoid fever upon mussel eaters, that an investigation into the bacterial contents of mussels imported into the city was being made.

In this special report, which has been since issued, and which is the work of Dr. G. F. Buchan, it is pointed out that during the past four years there have been 74 cases of enteric fever in which the patients partook of mussels within four weeks of the onset of the symptoms, and in 62 of such cases the onset of the disease occurred during the height of the mussel season, *i.e.*, at the end of September, and in October, November, December, and January. In 11 cases the onset was in February and March. Dr. Buchan observes, and the point is one of great administrative importance, that in no instance could the sources of mussels be definitely traced, as in every case they had been purchased by those who had bought the mussels without enquiry in the open market.

In 1909 there were 18 out of the 95 total cases which gave a history of eating shellfish.

As regards the behaviour of enteric fever in Birmingham, as illustrated by the accompanying table, it has to be pointed out that since 1903 a rapid conversion of pan-closets into water-closets has been taking place, as will be seen by the figures given below, which are taken from Dr. Robertson's report for 1909:—

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[*] The Medical Officer of Health gives reasons for believing that the estimated population is between 35,000 and 40,000 in excess of the actual population.

Year.	No. of Pan-closets converted.	Notifications of Enteric Fever.	Year.	No. of Pan-closets converted.	Notifications of Enteric Fever.
1897	105	533	1903	2,395	348
1898	210	637	1904	2,283	248
1899	199	779	1905	3,580	209
1900	275	851	1906	3,183	191
1901	486	615	1907	2,643	248
1902	871	544	1908	2,426	193
			1909	1,736	95

Dr. Robertson draws attention to the fact that coincident with this conversion, progressive yearly decrease has taken place in the number of enteric fever cases notified, and he adds that "there seems little doubt that the improved sanitary condition of the city has a strong influence on this progressive decline of typhoid fever prevalence."

Death-rate per 100,000.

Year.	Rate.	Year.	Rate	Year.	Rate.	Year.	Rate.
1887 ...	17	1893 ...	19	1899 ...	23	1905 ...	7
1888 ...	14	1894 ...	21	1900 ...	35	1906 ...	7
1889 ...	9	1895 ...	17	1901 ...	21	1907 ...	9
1890 ...	14	1896 ...	21	1902 ...	19	1908 ...	9
1891 ...	18	1897 ...	18	1903 ...	12	1909 ...	4
1892 ...	8	1898 ...	22	1904 ...	7		

(Census population (1891) 478,113; (1901) 522,204.)

Sources of Mussel Supply.

Aberdovey, Conway, Penclawdd—Wales; Teignmouth, Lympstone—South Devon; Morecambe, Glasson Dock—Lancashire; Rotterdam—Holland; O'Meath, Belfast, Killorglin, Oranmore—Ireland; Annan, Scotland.

Bolton.

(Population (1909) 187,824.)

Dr. J. E. Gould states that during 1908 there was a larger number of cases of enteric fever than in 1907, and that the autumnal increase began rather earlier than is usual in Bolton; it began in August instead of September. He also adds that the number of cases traced to eating shellfish was greater than in previous years.

Dr. Gould then furnishes details of one case which occurred in 1907, and 14 which occurred in 1908; and in 10 of these the dates of attack would be consistent with a view that they were due to the shellfish. In five cases the dates at which shellfish were eaten were not known. The 1908 cases occurred—3 in March, 1 in May and July, respectively, 4 in October, 3 in November, and 2 in December, facts which suggest that the shellfish were not important agents in the alteration of the seasonal prevalence referred to:—

Enteric and Continued Fever.

Year.	Cases.	Year.	Cases.	Year.	Cases.	Year.	Cases.
1890 ...	102	1895 ...	238	1900 ...	208	1905 ...	165
1891 ...	145	1896 ...	186	1901 ...	219	1906 ...	197
1892 ...	98	1897 ...	125	1902 ...	196	1907 ...	135
1893 ...	170	1898 ...	208	1903 ...	180	1908 ...	192
1894 ...	118	1899 ...	321	1904 ...	160	1909 ...	138

Census population (1891) 146,487; (1901) 168,215.)

Enteric Fever Death-rate per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1883 ...	15	1890 ...	18	1897 ...	20	1904 ...	21
1884 ...	23	1891 ...	26	1898 ...	28	1905 ...	19
1885 ...	15	1892 ...	16	1899 ...	33	1906 ...	22
1886 ...	10	1893 ...	28	1900 ...	28	1907 ...	14
1887 ...	27	1894 ...	20	1901 ...	23	1908 ...	19
1888 ...	27	1895 ...	41	1902 ...	21	1909 ...	17
1889 ...	27	1896 ...	41	1903 ...	20		

Sources of Shellfish.

Oysters.—America, Holland, Whitstable.

Mussels.—Killorglin (Ireland), Southport, Morecambe, Conway, Devonshire, Scotland.

Cockles.—Killorglin (Ireland), Southport, Morecambe.

Greater quantity arrives between September and March.

Bristol.

(Population (1909) 377,642.)

During the year 1906, out of 120 cases of enteric fever notified, 21 in all may have been due to shellfish (mussels), 6 of such cases having occurred in the family of a shellfish vendor, who, however, denies that any of the family partook of shellfish.

In 1907 there were 74 cases notified, and in 15 of them there was a history of shellfish consumption.

In 1908, out of 105 cases notified, 9 had taken shellfish at a date which would explain infection, while 11 others, although having eaten shellfish, had done so too early or too late to account for the attack. One case had been engaged in cleaning shellfish.

Notifications of Enteric Fever.

Year.	Notifications.	Year.	Notifications.	Year.	Notifications.
1890	122	1897... ...	350	1904... ...	172
1891	116	1898... ...	113	1905... ...	76
1892	135	1899... ...	219	1906... ...	120
1893	122	1900... ...	293	1907... ...	74
1894	90	1901... ...	281	1908... ...	103
1895	89	1902... ...	319	1909... ...	66
1896	110	1903... ...	134		

Death-rate from Enteric Fever per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1890 ...	14	1895 ...	9	1900 ...	13	1905 ...	3
1891 ...	10	1896 ...	8	1901 ...	12	1906 ...	5
1892 ...	8	1897 ...	20	1902 ...	17	1907 ...	4
1893 ...	11	1898 ...	8	1903 ...	6	1908 ...	2
1894 ...	10	1899 ...	10	1904 ...	7	1909 ...	3

(Census population (1891) 289,280; (1901) 328,945.)

Sources of Shellfish.

Mussels.—Wexford, Waterford—Ireland; Kidwelly, Ferryside—South Wales; Braunton, Appledore—North Devon; Lympstone, Teignmouth—South Devon.

Cockles.—Laugharne, Kidwelly, Ferryside, Llansaint, Burry Port—South Wales; Lynn—Norfolk; Boston—Lincolnshire; Leigh-on-Sea—Essex.

Cardiff.

(Population (1909) 195,303.)

Dr. Walford informs me that there have been during recent years the following number of possible shellfish-borne cases of enteric fever:—1902, 2; 1903, 5; 1904, 0; 1905, 0; 1906, 2; 1907, 0; 1908, 2; 1909, 2: and the notified cases of this disease have been year by year as follows:—

Year.	Cases.	Year.	Cases.	Year.	Cases.	Year.	Cases.
1890 ...	150	1895 ...	79	1900 ...	95	1905 ...	39
1891 ...	130	1896 ...	74	1901 ...	73	1906 ...	77
1892 ...	118	1897 ...	117	1902 ...	69	1907 ...	62
1893 ...	103	1898 ...	80	1903 ...	100	1908 ...	55
1894 ...	62	1899 ...	94	1904 ...	40	1909 ...	46

(Census population (1891) 128,915; (1901) 164,333.)

Death-rate from Enteric Fever per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1883 ...	38	1890 ...	19	1897 ...	13	1904 ...	5
1884 ...	36	1891 ...	19	1898 ...	11	1905 ...	4
1885 ...	21	1892 ...	18	1899 ...	12	1906 ...	7
1886 ...	62	1893 ...	13	1900 ...	15	1907 ...	7
1887 ...	15	1894 ...	5	1901 ...	6	1908 ...	3
1888 ...	31	1895 ...	9	1902 ...	5	1909 ...	3
1889 ...	25	1896 ...	8	1903 ...	8		

Sources of Shellfish.

From enquiries made by Dr. Walford of Messrs. N. & W., the largest wholesale fish dealers in South Wales, it appears that most of the Cardiff shellfish (excepting oysters) comes from Milford, Plymouth or Looe in Cornwall.*

Oysters, for the most part, come from the Mumbles, Swansea.

Derby.

(Population (1909) 129,411.)

Dr. A. E. Brindley refers to four cases of enteric fever which occurred during 1908, in which shellfish had been consumed at dates consistent with their having been due to this cause: —

Year.	Cases.	Year.	Cases.	Year.	Cases.	Year.	Cases.
1890 ...	64	1895 ...	99	1900 ...	125	1905 ...	44
1891 ..	66	1896 ...	104	1901 ...	114	1906 ...	71
1892 ...	55	1897 ...	125	1902 ...	85	1907 ...	74
1893 ...	111	1898 ...	159	1903 ...	64	1908 ...	39
1894 ...	104	1899 ...	141	1904 ...	64	1909 ...	13

Death-rate from "Fever" per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1892 ...	8	1897 ...	25	1902 ...	12	1907 ...	14
1893 ...	23	1898 ...	27	1903 ...	6	1908 ...	4
1894 ...	26	1899 ...	14	1904 ...	6	1909 ...	2
1895 ...	18	1900 ...	19	1905 ...	7		
1896 ...	20	1901 ...	21	1906 ...	9		

(Census population (1891) 94,146; (1901) 105,912.)

Sources of Supply.

Oysters.—Liverpool, Billingsgate, Whitstable, Grimsby.

Mussels.—Boston, Lynn, Lympstone, Killorglin (Ireland), Hull, Teignmouth, Morecambe.

Cockles.—Holy Island, Hull, Boston, Lynn.

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* Apparently the cockles come mainly from Boston in Lincolnshire (*see* p. 148).

Halifax.

(Population (1909) 111,911.)

From November 1st, 1908, to February 20th, 1909, 11 cases of enteric fever were suspected to be due to mussels and 1 to oysters, and during this period 40 cases of enteric fever were notified.

Dr. Neath, the medical officer of health, adds that for several years past two or three cases of enteric fever have apparently been associated with the eating of shellfish, but never before in anything like the degree which occurred in 1908-9.

Two persons who had eaten shellfish in connexion with the above cases were ill with sickness and vomiting, but did not develop enteric fever.

Year.	Cases.	Year.	Cases.	Year.	Cases.	Year.	Cases.
1891 ...	114	1896 ...	110	1901 ...	67	1906 ...	38
1892 ...	65	1897 ...	79	1902 ...	66	1907 ...	60
1893 ...	74	1898 ...	81	1903 ...	61	1908 ...	53
1894 ...	54	1899 ...	92	1904 ...	47	1909 ...	44
1895 ...	61	1900 ...	79	1905 ...	50		

(Census population (1891) 97,714; (1901) 104,936.)

Death-rate from "Fever" per 100,000.

Year.	Rate.	Year.	Rate	Year	Rate.	Year.	Rate.
1892 ...	10	1897 ...	17	1902 ...	14	1907 ...	7
1893 ...	14	1898 ...	19	1903 ...	12	1908 ...	11
1894 ...	6	1899 ...	25	1904 ...	9	1909 ...	6
1895 ...	17	1900 ...	22	1905 ...	6		
1896 ...	21	1901 ...	12	1906 ...	4		

It will be noted by the above table that there has been a notable decrease in enteric fever within recent years, and Dr. Neath thinks that such diminution cannot be accounted for by a lessened consumption of shellfish, since prior to 1908 it was never possible to associate more than two or three cases of enteric fever with shellfish. He suggests that either the shellfish are becoming year by year more polluted or the experience of Halifax in 1908 was exceptionally unfortunate.

Sources of Shellfish.

Oysters.—Whitstable, Hunstanton, Stranraer (Scotland), relaid Dutch (Brightlingsea).

Mussels.—Morecambe Bay, North Wales.

Cockles.—Lancashire Coast, Hook of Holland.

The chief trade in shellfish is done in October, November, and December.

Hull.

(Population (1908) 275,552.)

Dr. J. Wright Mason states that it has always been a direction to the inspectors when investigating cases of enteric fever to make inquiries as to the food supply especially with regard to shellfish, and upon the form used by the inspectors is the instruction: "If typhoid fever state whether patient has recently eaten oysters or other shellfish."

Dr. Mason has had no reason to attribute the source of infection in cases of enteric fever in Hull to shellfish.

Year.	"Fever" Cases.	Year.	"Fever" Cases.	Year.	"Fever" Cases.	Year.	"Fever" Cases.
1890 ...	160	1896 ...	354	1902 ...	181	1908 ...	118
1891 ...	215	1897 ...	284	1903 ...	109	1909 ...	91
1892 ...	160	1898 ...	341	1904 ...	204		
1893 ...	691	1899 ...	307	1905 ...	132		
1894 ...	242	1900 ...	223	1906 ...	269		
1895 ...	309	1901 ...	232	1907 ...	97		

(Census population (1891) 200,472; (1901) 240,259.)

Death-rate from "Fevers" per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1883 ...	36	1889 ...	21	1895 ...	22	1900 ...	20	1905 ...	8
1884 ...	40	1890 ...	17	1896 ...	27	1901 ...	22	1906 ...	19
1885 ...	20	1891 ...	18	1897 ...	23	1902 ...	18	1907 ...	5
1886 ...	14	1892 ...	15	1898 ...	24	1903 ...	6	1908 ...	8
1887 ...	14	1893 ...	45	1899 ...	18	1904 ...	14	1909 ...	4
1888 ...	16	1894 ...	15						

Sources of Shellfish.

Mussels.—Rotterdam, Harlingen (Holland).
Cockles.—Harlingen (Holland).

Mussels are imported twice weekly, the amount varying from 100 to 200 bags per week.

Cockles arrive during the season only.

About 30 per cent. of the shellfish landed at Hull is consumed in the city, and presumably there are no other sources of supply than those stated above.

Leeds.

(Population (1909) 484,012.)

Dr. Spottiswoode Cameron expresses the opinion, from inquiries made during the past few years, that enteric fever from the consumption of shellfish is not at all a frequent occurrence, and he furnishes a list of 84 enteric fever cases which occurred from

September 1st, 1908, to January 2nd, 1909. Of these no shellfish were consumed during the period of incubation by any but 14 cases.

Death-rate from "Fever" per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1890 ...	30	1895 ...	22	1900 ...	20	1905 ...	12
1891 ...	20	1896 ...	21	1901 ...	19	1906 ...	11
1892 ...	17	1897 ...	21	1902 ...	18	1907 ...	6
1893 ...	30	1898 ...	23	1903 ...	13	1908 ...	5
1894 ...	14	1899 ...	17	1904 ...	11	1909 ...	9

(Census population (1891) 367,505; (1901) 428,968.)

Sources of Shellfish.

Information in this sense is, Dr. Cameron reports, exceedingly difficult to get. "It may be taken generally that mussels, cockles, and other shellfish begin to arrive in quantities about September and continue to do so till about April, although there are often a few on sale between April and September. The principal sources are Ireland and the Morecambe district of Lancashire, the Lancashire coast, Holland, the Welsh coast and the Solway and the bays off it. The Dutch shellfish are regarded as poor in quality and are often dirty."

There is great unwillingness on the part of the vendors to state where they get their shellfish, principally on the ground that they do not wish their competitors to know their source of supply.

Leicester.

(Population (1909) 244,255.)

The subject of mussel-borne enteric fever is discussed by Dr. Millard in his annual report for the year 1908, where he states that although inquiries have been made for some years past in all cases of enteric fever as to whether mussels had been eaten, it was not until the latter end of 1908 that there was any serious ground for suspecting that these mussels were a source of the disease in question.

From inquiries which have been made as to the primary cases of enteric fever which occurred during the mussel season (November to February) since 1904-5, the following results were ascertained:—

Year.	Primary cases of Enteric Fever.	Cases with history of eating shellfish.	Percentage.
1904–5	18	3	16·6
1905–6	28	4	14·3
1906–7	21	6	28·6
1907–8	13	1	7·7
1908–9	26	13	50·0
1909–10	11	3	27·3

(Census population (1891) 174,624; (1901) 211,579.)

As regards the 13 cases which occurred after eating mussels either frequently or from 7 to 19 days before attack, inquiries were made as a control in 33 houses where no cases of enteric fever had occurred, and it was found that there was a history of eating mussels in only 5 cases, *i.e.*, 15·1 per cent.

Death-rate from Enteric Fever per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1881 ...	23	1889 ...	14	1897 ...	19	1905 ...	4
1882 ...	15	1890 ...	15	1898 ...	13	1906 ...	6
1883 ...	12	1891 ...	16	1899 ...	14	1907 ...	2
1884 ...	12	1892 ...	9	1900 ...	12	1908 ...	3
1885 ...	26	1893 ...	25	1901 ...	9	1909 ...	2
1886 ...	13	1894 ...	14	1902 ...	5		
1887 ...	22	1895 ...	20	1903 ...	6		
1888 ...	22	1896 ...	21	1904 ...	6		

Dr. Millard observes that a marked decline in the prevalence of enteric fever has occurred throughout the country during the past thirty years, but that very few of the large towns have a lower rate than Leicester. He thinks the abolition of pail closets in Leicester, although not the only cause, may have materially contributed to the reduced prevalence of the disease. In support of this view he quotes from the annual report for 1907 of Dr. Boobbyer, the medical officer of health of Nottingham, at which place the history of enteric fever has shown but little variation except in details of distribution and concentration. Dr. Boobbyer explains this persistency by the dominant cause of the endemicity of the disease—the pail closet system—remaining essentially unaltered though slightly less potent for harm than formerly. There are still nearly 37,000 pail closets in the city.

Sources of Shellfish.

Oysters.—America, South Wales (Mumbles), Cleethorpes, Brightlingsea, Fleetwood, Relaid Portuguese, and Oysters from South-East Coast of England.

Mussels.—King's Lynn, Boston, Brancaster, Sutton Bridge, Ireland, and Holland, *viâ* Hull.

Cockles.—Holland, Southport, Morecambe, King's Lynn, and many other ports.

Liverpool.

(Population (1909) 760,357.)

Dr. Hope states that he is unable to recall any instances in which shellfish were definitely the cause of enteric fever. He adds, however, that owing to the fact that some years ago shellfish exposed in shops were found to be contaminated with sewage, the dealers were circularised and warned.

Year.	Cases.	Year.	Cases.	Year.	Cases.	Year.	Cases.
1890 ...	506	1895 ...	1,306	1900 ...	731	1905 ...	325
1891 ...	588	1896 ...	1,063	1901 ...	864	1906 ...	491
1892 ...	699	1897 ...	891	1902 ...	1,026	1907 ...	482
1893 ...	1,396	1898 ...	863	1903 ...	681	1908 ...	447
1894 ...	1,350	1899 ...	988	1904 ...	434	1909 ...	278

(Census population (1891) 629,548; (1901) 684,958.)

Death-rate from Enteric Fever per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1883 ...	20	1890 ...	19	1897 ...	22	1904 ...	11
1884 ...	21	1891 ...	18	1898 ...	22	1905 ...	7
1885 ...	18	1892 ...	21	1899 ...	27	1906 ...	11
1886 ...	26	1893 ...	42	1900 ...	18	1907 ...	12
1887 ...	24	1894 ...	47	1901 ...	22	1908 ...	10
1888 ...	24	1895 ...	30	1902 ...	27	1909 ...	7
1889 ...	32	1896 ...	25	1903 ...	15		

Sources of Shellfish.

Oysters.—America (15,491 barrels). Each barrel contains 12,000 living oysters. A large proportion are distributed for consumption to other towns and a considerable number relaid at Bangor (North Wales), Carlingford (Ireland), and other places, and disposed of during the close season for English oysters. Oysters are also supplied to Liverpool from Whitstable, Holland, and Ireland.

Mussels, Cockles, and Periwinkles.—Sligo, Londonderry, Killorglin, Cork, Dundalk, Donegal, and Wexford.

During 1908 about 5,000 bags of 2 cwt. each were received.

Newcastle-on-Tyne.

(Population (1909) 281,584.)

Dr. Henry Armstrong, medical officer of health of this city, states that although he has known of cases in which there was slight suspicion that enteric fever might have been due to shellfish, the evidence has never been more than very incomplete, and this notwithstanding the fact that the inspector who makes inquiries into the history of enteric fever cases has special instructions to ascertain the facts as regards shellfish, and this he has done for several years past.

"Fever" Notifications.

Year.	Cases.	Year.	Cases.	Year.	Cases.	Year.	Cases.
1890 ...	216	1895 ...	241	1900 ...	81	1905 ...	50
1891 ...	149	1896 ...	186	1901 ...	84	1906 ...	71
1892 ...	105	1897 ...	151	1902 ...	61	1907 ...	66
1893 ...	151	1898 ...	320	1903 ...	77	1908 ...	112
1894 ...	185	1899 ...	140	1904 ...	33	1909 ...	74

(Census population (1891) 186,300; (1901) 215,328.)

Death-rate from "Fever" per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.
1892	7	1898	30	1904	4
1893	13	1899	10	1905	4
1894	13	1900	8	1906	5
1895	23	1901	7	1907	4
1896	15	1902	5	1908	5
1897	16	1903	3	1909	6

Sources of Shellfish.

Mussels.—Morecambe Bay, Rotterdam, Dalbeattie, and Creetown (Scotland).

Cockles.—Boston, Hull, Craster, and Holy Island.

Nottingham.

(Population (1909) 263,441.)

Dr. Boobbyer refers to six cases of enteric fever which occurred in January, February, July, and August of 1908, in which mussels were consumed prior to attack, and in two of such cases the patients had eaten raw mussels within about three weeks of the onset of the disease.

He adds that his attention was drawn to certain consignments of mussels from Conway to retailers in Nottingham by the statement by one of the patients that the mussels in question had a bad smell, and Dr. Boobbyer observes that a few of the Conway mussels which were brought to him at that time (January and February, 1908) appeared to possess a distinct sewage odour. These mussels were examined by the borough bacteriologist, who found a bacillus which was stated to yield the reactions of the enteric fever bacillus (February 7th, 1908). After this Conway mussels submitted to bacteriological examination in Nottingham yielded only bacillus coli.

Dr. Boobbyer does not suggest that the cases which occurred in July and August were due to Conway mussels, since such mussels are not allowed to be gathered during these months.

Enteric Fever Notifications.

Year.	Cases.	Year.	Cases.	Year.	Cases.	Year.	Cases.
1890 ...	337	1895 ...	422	1900 ...	505	1905 ...	255
1891 ...	375	1896 ...	444	1901 ...	535	1906 ...	285
1892 ...	198	1897 ...	428	1902 ...	375	1907 ...	231
1893 ...	479	1898 ...	423	1903 ...	200	1908 ...	237
1894 ...	334	1899 ...	607	1904 ...	296	1909 ...	157

(Census population (1891) 213,877; (1901) 239,743.)

Death-rate from Enteric Fever per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1890 ...	27	1895 ...	24	1900 ...	32	1905 ...	9
1891 ...	33	1896 ...	34	1901 ...	33	1906 ...	16
1892 ...	15	1897 ...	21	1902 ...	21	1907 ...	15
1893 ...	31	1898 ...	22	1903 ...	14	1908 ...	11
1894 ...	28	1899 ...	48	1904 ...	23	1909 ...	7

It will be seen by the above table that although a decline in the death-rate has taken place within recent years, the mortality occasioned by the disease is still very great, a circumstance which Dr. Boobbyer attributes to the persistence of the conservancy system of excrement disposal.

In the Nottingham annual report for 1907 the following table is found relative to the incidence of enteric fever on different groups of houses.

1887-1898 (Averages).

Houses with pail closets ...	One case in 120 houses.
Houses with midden privies ...	,, ,, ,, 37 ,,
Houses with water-closets ...	,, ,, ,, 558 ,,

With reference to the enteric fever problem in Nottingham, Dr. Boobbyer has forwarded me the following interesting comments:—

"I have, as you know, for many years past, been disposed to attribute the greater part of the excess of enteric fever in Nottingham, directly or indirectly, to our pail-closets. Occasionally we have, in Nottingham, as elsewhere, outbreaks which are pretty clearly traceable to contaminated shellfish, milk, and other foods; but, independently of such incidentals, we have what I can only call our endemic series of cases, occurring year after year in practically the same poor neighbourhoods. Our typhoid, as I think you know, is almost exclusively confined to poor neighbourhoods.

"My note in the discussion on Dr. Darra Mair's paper, emphasizes a point which I think it will interest you to consider. Nottingham and Leicester are very similar towns, alike as regards size, physical conditions, and class of population. The great point of difference in municipal menage between the two places is that Leicester has abolished its pail-closets (during the past fifteen years), while we have retained ours—we have now more than 36,000. Both towns have practically the same shellfish supply. But look at the difference in enteric incidence between the two places. Formerly, before the conversion of its pail-closets, Leicester had more enteric than Nottingham. Now, since the conversion of its pail-closets, Leicester's typhoid has sunk to a negligible quantity, while ours is only slightly reduced below its old figure. During the ten years 1898-07, the death-rate in Leicester was 0·08, that in Nottingham 0·24, and during 1908 the Leicester rate was 0·03, while ours was 0·11. The actual deaths from enteric in Leicester last year were 8, while ours were 29."

Plymouth.

(Population (1909) 124,180.)

Dr. Williams reports that in no case has there been reason to suspect that shellfish has been the cause of enteric fever or other illness.

The total number of cases of enteric and continued fever notified during each of the last twelve years has been as follows:—

Year.	Cases.	Year.	Cases.	Year.	Cases.
1898	49	1902	42	1906	26
1899	51	1903	75	1907	49
1900	129	1904	77	1908	69
1901	82	1905	54	1909	29

(Census population (1891) 88,931; (1901) 107,636.)

Death-rate from "Fever" per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1885	22	1892	23	1899	10	1906	5
1886	54	1893	14	1900	21	1907	7
1887	21	1894	14	1901	19	1908	11
1888	20	1895	7	1902	7	1909	7
1889	19	1896	6	1903	12		
1890	32	1897	9	1904	16		
1891	18	1898	8	1905	8		

Sources of Shellfish.

Mussels.—Rarely receive any. Occasionally a few pass through the market, and are obtained from the girders of the pier at low tide. Source is apparently quite pure.

Cockles.—Few bags landed each week from L. & S.W.R. docks, and are imported from St. Brieuc in Brittany. Cockles collected from sands, and the medical officer of health states that this is a perfectly pure source.

Preston.

(Population (1909) 118,519.)

Dr. Pilkington informs me that although inquiry is made in cases of enteric fever as to the consumption of shellfish, he has not been able definitely to connect the disease with this article of diet. He states that there has certainly been no outbreak or succession of cases due to this article of food. It will be seen that the "Fever" death-rate is a very high one.

Number of Cases of Enteric Fever and Continued Fever notified.

Year.	Cases.	Year.	Cases.	Year.	Cases.	Year.	Cases.
1890 ...	161	1895 ...	135	1900 ...	174	1905 ...	119
1891 ...	148	1896 ...	131	1901 ...	140	1906 ...	156
1892 ...	155	1897 ...	201	1902 ...	154	1907 ...	118
1893 ...	117	1898 ...	233	1903 ...	143	1908 ...	144
1894 ...	114	1899 ...	223	1904 ...	129	1909 ...	114

(Census population (1891) 107,573; (1901) 112,989.)

Death-rate from "Fever" per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1892 ...	33	1897 ...	30	1902 ...	19	1906 ...	17
1893 ...	46	1898 ...	37	1903 ...	29	1907 ...	15
1894 ...	26	1899 ...	33	1904 ...	27	1908 ...	22
1895 ...	20	1900 ...	39	1905 ...	16	1909 ...	9
1896 ...	22	1901 ...	23				

Sources of Shellfish.

Oysters.—Whitstable, Holland, Hunstanton, Grimsby.
Mussels.—Hull, Lynn.
Cockles.—Lynn, Hull.

Rhondda.

(Population (1909) 135,894.)

Dr. J. D. Jenkins, the medical officer of health for this district, in dealing with the extent to which shellfish may have been operative in causation of enteric fever in this district, states that although inquiries have been made as to this question in the many instances upon which more or less limited epidemics of enteric fever have occurred in Rhondda, on no occasion has the evidence obtainable been regarded as justifying the opinion that the disease was conveyed by means of shellfish.

He adds that, having regard to the population of the district and to the working-class character of the people, the extent to which shellfish is sold is very limited, especially in the case of oysters and mussels.

The following table shows the death-rate from enteric fever in this district since 1879, and it will be noted that both in the past and in recent years up to 1909 the rate has been a remarkably high one:—

Death-rate from Enteric Fever per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1879 ...	63	1887 ...	37	1895 ...	25	1903 ...	36
1880 ...	69	1888 ...	29	1896 ...	27	1904 ...	34
1881 ...	49	1889 ...	24	1897 ...	27	1905 ...	12
1882 ...	50	1890 ...	23	1898 ...	37	1906 ...	16
1883 ...	50	1891 ...	27	1899 ...	50	1907 ...	17
1884 ...	85	1892 ...	35	1900 ...	21	1908 ...	16
1885 ...	56	1893 ...	97	1901 ...	46	1909 ...	3
1886 ...	69	1894 ...	29	1902 ...	18		

(Census population (1891) 88,351; (1901) 113,735.)

Sources from which Shellfish are procured.

From the accompanying table it will be seen that the greater number of mussels and cockles are derived from the coast of Carmarthenshire, and to a less extent from Boston in Lincolnshire. From this latter place pickled cockles are largely derived.

Rhondda Urban District.—Sale of Shellfish.

Initials of Vendor.	Address.	Whence obtained.	Fish sold.
A. H.	Treherbert	Kidwelly, Carmarthenshire.	Cockles and Mussels.
S. B.	"	" " "	" "
G. T.	Treorchy	Ferryside, Carmarthenshire.	" "
J. E.	"	" " "	" "
J. G.	Pentre	Kidwelly, Carmarthenshire.	" "
"	"	Mussen, Liverpool...	Oysters.
J. L.	Trealaw	Laugharne, Carmarthenshire.	Cockles and Mussels.
H. F.	Clydach Vale ...	Ferryside, Carmarthenshire.	" "

Initials of Vendor.	Address.	Whence obtained.	Fish sold.
L.	Clydach Vale ...	Laugharne, Carmarthenshire.	Cockles and Mussels.
J. G.	Tonypandy	McDonald & Sons, Liverpool (said to be derived from beds in Bangor, Cleethorpes, and Carlingford Loch).	Oysters.
"	"	Boston, Lincolnshire	Cockles.
R. P.	Wattstown	Laugharne, Carmarthenshire.	Cockles and Mussels.
F. H.	Tylorstown ...	Cardiff (? source) ...	Oysters and Cockles.
T. J.	Blaenllechau ...	Ferryside, Carmarthenshire.	Cockles.
J. U.	Maerdy	Boston, Lincolnshire	"

Information has also been gathered that at least two vendors of cockles living outside the district, hawk their goods in the streets in this district; the cockles in these cases are obtained from Ferryside and Kidwelly in Carmarthenshire.

Salford.

(Population (1909) 241,950.)

Dr. Tattersall reports that the evidence implicating shellfish in Salford is "exceedingly slight," notwithstanding the fact that since 1902 the question as to the possibility of shellfish being implicated in the causation of enteric fever has been kept continually before the inspectors who make the inquiries as to the sources of infection.

He furnishes, however, a list of cases of enteric fever in which suspicion arose that the source of infection might be the consumption of shellfish. In 1902, 2; in 1903, 8; in 1904, 9; in 1905, 6; in 1906, 5; in 1907, 1; and in 1908, 4.

The fact that shellfish is believed by the medical officer of health to have been an unimportant factor in enteric fever production in Salford is a matter of considerable interest, since Dr. Tattersall states that the sources of shellfish supply to Salford are similar to those of Manchester, where, as has been pointed out, a large number of cases are ascribed to this cause.

Year.	Cases.	Year.	Cases.	Year.	Cases.	Year.	Cases.
1890 ...	383	1895 ...	382	1900 ...	335	1905 ...	142
1891 ...	377	1896 ...	291	1901 ...	317	1906 ...	225
1892 ...	347	1897 ...	291	1902 ...	207	1907 ...	92
1893 ...	563	1898 ...	367	1903 ...	178	1908 ...	181
1894 ...	316	1899 ...	273	1904 ...	202	1909 ...	138

Death-rate from "Fever" per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1892 ...	41	1897 ...	31	1902 ...	27	1906 ...	18
1893 ...	49	1898 ...	37	1903 ...	22	1907 ...	8
1894 ...	31	1899 ...	35	1904 ...	23	1908 ...	17
1895 ...	42	1900 ...	31	1905 ...	19	1909 ...	18
1896 ...	33	1901 ...	33				

(Census population (1891) 198,139; (1901) 220,957.)

Sheffield.

(Population (1909) 470,958.)

Dr. Harold Scurfield, the medical officer of health of the city, reports that in 1907 oysters had been consumed in two cases and mussels in ten, while in 1908 there was a history of oysters having been consumed in six instances, mussels in fourteen, and cockles in two. It was not practicable to obtain the dates at which such shellfish were eaten, as the inspectors find it very difficult to procure anything like accurate information as to when the shellfish are consumed prior to the attack.

Death-rate from "Fever" per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1892 ...	12	1897 ...	31	1902 ...	11	1907 ...	9
1893 ...	27	1898 ...	40	1903 ...	11	1908 ...	6
1894 ...	19	1899 ...	51	1904 ...	12	1909 ...	7
1895 ...	28	1900 ...	28	1905 ...	10		
1896 ...	29	1901 ...	31	1906 ...	12		

Sources of Shellfish.

Oysters.—Cleethorpes, Liverpool, Fleetwood, Hunstanton. Throughout the year.

Mussels.—Hull, Morecambe, Harlingen (Holland), Boston, Fleetwood, Creetown, Kanllar, Killorglin. During first and last quarters of year.

Cockles.—Hull, Harlingen (Holland), Boston, Grimsby, Glenfinnan. During first and last quarters of year.

Sunderland.

(Population (1909) 150,378.)

Dr. Henry Renney reports that during the year 1908, 12 cases of enteric fever (out of 132 notified) gave a history of mussels have been eaten at a sufficiently recent date to suggest that the illness may have been due to the shellfish.

In some of these cases there was diarrhœa and vomiting, which subsided, and after an interval symptoms of enteric fever supervened.

In his annual report for 1908, Dr. Renney points out that the localities where mussels may be obtained in the vicinity of the River Wear and on the foreshore are so numerous that it would not be practicable to indicate the danger which arises from eating these molluscs by exhibiting notice boards. He has, however, sent a circular to all head teachers of the Council schools, requesting them to advise the scholars of the risk they incur from eating shellfish gathered in the vicinities referred to, and he suggests in this circular that the children should be instructed to tell their parents of the danger.

It will be interesting, therefore, to note to what extent the prevalence of enteric fever may diminish in the future. It will be noticed by the figures which follow that a great increase took place in 1893, 1894, and 1895, and that during recent years a marked decrease has taken place:—

Sunderland.

Number of Cases of Typhoid and Continued Fever notified.

Year.	Typhoid Fever.	Continued Fever.
1889	170	37
1890	311	102
1891	271	85
1892	284	104
1893	801	117
1894	588	80
1895	840	99
1896	260	46
1897	203	29
1898	452	50
1899	297	48
1900	301	32
1901	244	22
1902	211	19
1903	121	14
1904	128	9
1905	139	6
1906	134	7
1907	92	6
1908	132	1
1909	96	2

(Census population (1891) 131,686; (1901) 146,077.)

Death-rate from "Fever" per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1888 ...	22	1894 ...	60	1900 ...	37	1906 ...	14
1889 ...	28	1895 ...	96	1901 ...	29	1907 ...	7
1890 ...	35	1896 ...	37	1902 ...	23	1908 ...	9
1891 ...	40	1897 ...	27	1903 ...	16	1909 ...	9
1892 ...	43	1898 ...	48	1904 ...	21		
1893 ...	98	1899 ...	38	1905 ...	20		

Dr. Renney has always considered the diminishing prevalence of enteric fever in Sunderland to have been largely due to the abolition of privy-middens, and the subjoined table indicates the number of such middens which have been abolished annually from 1896-1908.

In 1900 the Corporation obtained a Provisional Order for the abolition of privy-middens, and, since then, the oldest and most insanitary privy-middens have been abolished and water-closets substituted—more especially has this been the case since 1903.

Enteric fever was, Dr. Renney tells me, at one time very prevalent in certain districts of the town where privy-middens were the rule, but, since they have been abolished, it is rare for a case of this disease to be notified from these districts.

Sources of Shellfish.

Mussels are gathered from rocks on the seashore from the bed of the Wear and from the quay walls. In nearly every case the mussels are exposed to pollution from sewage. Some of the beds are close to sewer outfalls. The source of the cockles cannot be ascertained.

Dr. Renney tells me that he is unable to satisfy himself that this practice of eating shellfish has increased recently, but he thinks it possible that it may have done so during the last two years owing to the distress which has prevailed in the town. It is likely, he adds, that people living in the poorer neighbourhoods may themselves have gathered shellfish from the rocks on the foreshore, who would not have done so had they been at work.

There are two shops in Sunderland where shellfish are sold in the borough. One is patronised by people of the better class, the other is situated in a second-rate street but not in the slums or in a district in which enteric fever prevails. Another shop, opposite one of the theatres, sells shellfish intermittently.

There are also a good many hawkers who sell shellfish, notably in public-houses.

Sunderland.

Year.	Privy-middens abolished.	Water-closets substituted.	Cases of Enteric Fever and Continued Fever.
1896	331	318	306
1897	605	643	232
1898	215	238	502
1899	145	168	345
1900*	120	147	333
1901	145	170	266
1902	380	418	230
1903	703	848	135
1904	1,193	1,240	137
1905	1,922	1,964	145
1906	1,896	1,865	141
1907	1,590	2,090	98
1908	768	768	133
1909	686	686	98

* Provisional Order came into force July 30th, 1900.

St. Helens.

(Population (1909) 95,161.)

Dr. Buchan, the medical officer of health, has furnished me with the following particulars relative to shellfish and enteric fever:—

Notifications of Enteric Fever.

Year.	Cases.	Year.	Cases.	Year.	Cases.	Year.	Cases.
1890 ...	150	1895 ...	257	1900 ...	123	1905 ...	37
1891 ...	185	1896 ...	166	1901 ...	164	1906 ...	99
1892 ...	138	1897 ...	147	1902 ...	81	1907 ...	61
1893 ...	315	1898 ...	136	1903 ...	76	1908 ...	90
1894 ...	172	1899 ...	221	1904 ...	61	1909 ...	66

(Census population (1891) 72,413; (1901) 84,410.)

Cases of Enteric Fever in which Shellfish had been partaken of.

Year.	Total cases of Enteric Fever.	Cases which had partaken of shellfish.	Possibility of shellfish infection.		
			Possible.	Improbable.	Impossible.
1904	61	1	1	—	—
1905	37	3	2	1	—
1906	99	9	4	—	5
1907	61	1	—	1	—
1908	90	2	1	1	—
Totals ...	348	16	8	3	5

Death-rate from Enteric Fever per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1890 ...	34	1895 ...	74	1900 ...	21	1905 ...	2
1891 ..	36	1896 ...	49	1901 ...	40	1906 ...	19
1892 ...	34	1897 ...	39	1902 ...	29	1907 ...	12
1893 ...	68	1898 ...	36	1903 ...	20	1908 ...	12
1894 ...	33	1899 ...	49	1904 ...	14	1909 ...	13

Relationship of Shellfish to Possibility of Infection.

Fish.	Possible.	Improbable.	Impossible.
Oysters	1	—	—
Mussels	4	1	4
Cockles	2	2	1
Mussels and cockles	1	—	—

Particulars of cases in which Shellfish had been partaken of.

1904.

R., woman aged 30 years, sickened about the beginning of September, and had frequently consumed oysters. Possible case of shellfish infection.

1905.

C., man aged 23, sickened on the 22nd February. Had Irish mussels, got from Cork, about that time. Possible case.

K., woman aged 30, sickened on the 7th October. Had partaken of mussels and cockles. Possible case.

C., man aged 49 years, sickened about the 27th March. Had partaken of mussels about that time. Improbable case of shellfish infection.

1906

M., woman aged 32, sickened on 15th March. Had mussels some weeks previously. Possible case.

C., woman aged 36, sickened on the 16th March. Had mussels a fortnight before. Possible case.

E., man aged 29, sickened on the 28th March. Had cockles on the 14th March. Possible case.

C., girl aged 15 years, sickened on the 2nd September. Partook of mussels three weeks before. Other sources of infection. Impossible case of shellfish infection.

T., man aged 36, sickened on the 8th October. Partook of cockles about a month before. Possible case.

B., man aged 29 years, sickened 13th October. Had mussels just before time of sickening. Another source of infection. Impossible case.

I., man aged 26, sickened on the 26th October. Partook of mussels about three weeks before sickening. Another source of infection here. Impossible case.

C., girl aged 19, sickened on the 5th November. Had mussels on the 30th October. Impossible case.

W., man aged 28, sickened on the 27th November. Had cockles on the 26th November only. Impossible case.

1907.

R., man aged 21 years, sickened on the 9th March. About this time he partook of cockles. Another case of diarrhœa in the house. Improbable case of shellfish infection.

1908.

W., girl aged 12 years, sickened on the 21st May. Cockles were eaten once a week in this household of 8 persons, in which this was the only case. Improbable case.

E., boy aged 5 years, sickened on the 30th October. Had mussels sometime about the date of infection. Possible case of shellfish infection.

Sources of Shellfish.

Oysters.—1,400 weekly; from wholesale Fish Market, Liverpool.

Mussels.—82 cwt. weekly; 8 cwt. from Liverpool Market and 75 cwt. from Morecambe.

Cockles.—68 cwt. weekly; 66 cwt. from Southport and 2 cwt. from Liverpool.

Swansea.

(Population (1909) 98,308.)

The following return relative to the number of cases of enteric fever which year by year may have had their origin in the consumption of cockles, mussels, and oysters has been sent to me by Dr. David J. Morgan, medical officer of health of Swansea.

Year.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	Total.
No. of Cases of Enteric notified.	92	83	100	52	85	52	50	63	46	35	657
No of cases in which cockles were eaten.	Particulars cannot be obtained.				33	4	2	9	5	5	58
No. of cases in which mussels were eaten.					1	1	2	–	1	–	5
No. of cases in which oysters were eaten					1	–	1	–	–	–	2

Death-rate from "Fever" per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1892 ...	26	1897 ...	7	1902 ...	6	1907 ...	4
1893 ...	20	1898 ...	13	1903 ...	12	1908 ...	1
1894 ...	13	1899 ...	8	1904 ...	5	1909 ...	4
1895 ...	21	1900 ...	15	1905 ...	5		
1896 ...	15	1901 ...	18	1906 ...	10		

(Census population (1891) 91,034; (1901) 94,537.)

Sources of Shellfish.

Mussels.—Penclawdd. *Cockles.*—Penclawdd, Swansea Sands (a few only).

York.

(Population (1909) 87,004.)

Dr. Edmund M. Smith states that inquiries relative to the association of shellfish in York have been made—at any rate as regards oysters—since the beginning of the year 1901, but it was not until the autumn of 1906 that any cases could be definitely associated with the consumption of shellfish. He adds that very few persons among the working classes of York appear to consume shellfish.

Dr. Smith furnishes a list of four cases of enteric fever which occurred in association with shellfish between November, 1906, and August 28th, 1908, three of such cases being soldiers.

In the autumn of 1905, in consequence of a communication received from the Fishmongers' Company as to the pollution of the Cleethorpes oyster beds, warning notices were issued in York.

Year.	Cases.	Year.	Cases	Year.	Cases.	Year.	Cases.	Year.	Cases.
1890	156	1894	95	1898	132	1902	56 nett	1906	75 nett
1891	119	1895	180	1899	134	1903	47 „	1907	30 „
1892	179	1896	101	1900	244	1904	89 „	1908	50 „
1893	287	1897	106	1901	121	1905	63 „	1909	38 „

(Census population (1891) 67,841; (1901) 77,914.)

Death-rate from "Fever" per 100,000.

Year.	Rate.	Year.	Rate.	Year.	Rate.	Year.	Rate.
1890 ...	33	1895 ...	30	1900 ...	49	1905 ...	9
1891 ...	38	1896 ...	15	1901 ...	19	1906 ...	16
1892 ...	38	1897 ...	29	1902 ...	15	1907 ...	9
1893 ...	59	1898 ...	22	1903 ...	6	1908 ...	8
1894 ...	8	1899 ...	34	1904 ...	17	1909 ...	3

Sources of Supply.

Oysters.—Whitstable, Cleethorpes, Jereseke (Holland), Hunstanton, Hull, Grimsby.

Mussels.—Hull, Lynn.

Cockles.—Lynn, Hull.

Summary of Chapter.

Taking now a general view of all the tables relative to "fever" in this chapter, it is seen that in a large number of cases a marked fall in enteric fever mortality commenced somewhere about the year 1900. In some instances this fall began prior to 1900, in others it was delayed until 1903 or 1904, a fact which is well brought out by the accompanying table, wherein all the towns referred to are grouped together.

Table showing Death-rate from Enteric Fever per 100,000 *population from* 1890 *to* 1909 *in the Towns referred to in this Chapter.*

DIVISION 1.

Towns.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.
Brighton ...			7	13	9	12	12	17	15	20	10	5	11	3	5	2	2	2	4	5
Exeter* ...					19	24	35	45	19	48	40	13	6	2	8	6	10	4	0	2
Grimsby* ...					48	40	28	18	40	40	21	55	43	29	19	16	14	21	19	25
Ipswich* ...	14	28	12	33	6	18	12	9	10	49	18	21	47	8	10	9	5	4	1	4
Manchester ...	27	37	24	25	17	18	22	18	22	13	14	14	12	17	12	9	14	6	11	13
Portsmouth*	35	22	26	31	16	20	15	24	23	40	47	22	28	12	17	9	8	14	12	15
Southampton*					18	15	15	7	27	20	16	10	17	18	2	9	5	4	4	10
Southend ...				118	78	49	51	72	71	24	22	27	37	27	4	17	4	9	5	0
Yarmouth* ...					20	22	33	35	88	50	25	23	13	12	10	11	13	9	9	0
Belfast ...	67	54	40	43	54	62	50	119	193	81	77	100	46	39	31	35	25	22	15	5
DIVISION 2.																				
Birmingham	14	18	8	19	21	17	21	18	22	23	35	21	19	12	7	7	7	9	9	4
Bolton ...	18	26	16	28	20	41	41	20	28	33	28	23	21	20	21	19	22	14	19	17
Bristol ...	14	10	8	11	10	9	8	20	8	10	13	12	17	6	7	3	5	4	2	3
Cardiff ...	19	19	18	13	5	9	8	13	11	12	15	6	5	8	5	4	7	7	3	3
Derby* ...	17	13	8	23	26	18	20	25	27	14	19	21	12	6	6	7	9	14	4	2
Halifax* ...	18	25	10	14	6	17	21	17	19	25	22	12	14	12	9	6	4	7	11	6
Hull*... ...	17	18	15	45	15	22	27	23	24	18	20	22	18	6	14	8	19	5	8	1
Leeds* ...	30	20	17	30	14	22	21	21	23	17	20	19	18	13	11	12	11	6	5	9
Leicester ...	15	16	9	25	14	20	21	19	13	14	12	9	5	6	6	4	6	2	3	2
Liverpool ...	19	18	21	42	47	30	25	22	22	27	18	22	27	15	11	7	11	12	10	7
Newcastle* ...	23	15	7	13	13	23	15	16	30	10	8	7	5	3	4	4	5	4	5	6
Nottingham...	27	33	15	31	28	24	34	21	22	48	32	33	21	14	23	9	16	15	11	7
Plymouth* ...	32	18	23	14	14	7	6	9	8	10	21	19	7	12	16	8	5	7	11	7
Preston* ...	28	31	33	46	26	20	22	30	37	33	39	23	19	29	27	16	17	15	22	9
Rhondda ...	23	27	35	97	29	25	27	27	37	50	21	46	18	36	34	12	16	17	16	3
Salford* ...	35	38	41	49	31	42	33	31	37	35	31	33	27	22	23	19	18	8	17	18
Sheffield* ...	21	24	12	27	19	28	29	31	40	51	28	31	11	11	12	10	12	9	6	7
Sunderland*	35	40	43	98	60	96	37	27	48	38	37	29	23	16	21	20	14	7	9	9
St. Helens ...	34	36	34	68	33	74	49	39	36	49	21	40	29	20	14	2	19	12	12	13
Swansea* ...			26	20	13	21	15	7	13	8	15	18	6	12	5	5	10	4	1	4
York* ...	33	38	38	59	8	30	15	29	22	34	49	19	15	6	17	9	16	9	8	3

* Fever.

Whether we are dealing with towns in which the shellfish question has been conspicuous or whether with towns in which no great attention has been paid to the matter, and where practically but few, if any, cases have been attributed to shellfish influence, it is found that in very many instances, during one or another of the years between 1898-1902, a decided fall in the enteric fever death-rate occurred, which has for the most part been maintained.

Had such fall been limited to towns in which shellfish influence had been great, and the attention drawn to the matter considerable, the proportions of the problem relative to shellfish would have been greatly simplified.

It is, of course, not improbable that the shellfish-borne outbreaks which have occurred in recent years have served to draw attention to the danger of consuming raw shellfish in promiscuous fashion and that there has consequently been abstention from shellfish in many of our large towns, the result manifesting itself in different years in different places, but the evidence so far obtained is not sufficient to justify a positive statement on this point.

But these considerations do not raise question as to the part played by shellfish in certain towns where the history of individual cases has been carefully worked out by the medical officers of health and where all other causes likely to induce enteric fever have been investigated and excluded.

They may, however, be regarded as provisionally suggesting that in one town shellfish, in another the abolition of the conservancy methods of excrement disposal, and in another the removal of some other cause as yet unrecognised may have been the *dominant* factor in promoting the decline of the enteric fever death-rate which has taken place; and it may be that in some places enteric fever is being, as probably was the case in Belfast, unwittingly maintained by the non-recognition of shellfish influences. Finally, it is possible that some unrecognised change of circumstances has diverted the supply of polluted shellfish from a given town.

THE INCREASING PRACTICE OF ISOLATING CASES OF ENTERIC FEVER IN HOSPITAL AS A FACTOR IN REDUCING THE NUMBER OF "CONTACT" CASES.

It must not of course be lost sight of that the practice of isolating cases of enteric fever in fever hospitals has grown materially during recent years, especially in certain towns. Such isolation has in all probability reduced the number of contact cases and thus aided in promoting the fall both in the prevalence-rates and death-rates from this malady. The painstaking inquiries organised by Dr. Niven* in Manchester serve to show what a large proportion of enteric fever in some towns may be due to contact.

As illustration of the progressive increase in the isolation of enteric fever cases, attention may be directed to the conditions obtaining at the following towns:—

In London, as the annual report for 1908 of the Metropolitan Asylums Board shows, the number of cases of enteric fever sent to hospital has now reached 50 per cent. as against 22·5 per cent. in 1890.

At Ipswich, where the proportion of total enteric fever cases isolated was in the five years 1893-97 only 34 per cent., in the five years 1898-1902 it rose to 61 per cent., and in the five years 1903-1907 to no less than 81 per cent.

In the case of the City of Birmingham it appears from a table on page 77 of the annual report for the year 1908, that up to and including the year 1900 no cases were admitted into the isolation hospital. In 1901 the proportion admitted was 37·2 per cent., and in 1908 57 per cent.

In Portsmouth nearly 50 per cent. of the cases notified were isolated during 1907 and 1908. In Sunderland, 59·6 were isolated in 1907, and 67·0 in 1908. At Nottingham, out of 237 cases notified, 78 per cent. of all known cases were removed from their homes, *i.e.*, either to the isolation hospital, the general hospital, or the union workhouse infirmary. In Liverpool the proportion rose from 45 per cent. in 1889 to over 80 per cent. in 1908. In St. Helen's, in 1908, no less than 98·8 per cent. of the cases notified were sent to hospital. In Cardiff the percentage removed has increased from 13 in 1895 to 78 in 1909.

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* *See* Proceedings of Royal Society of Medicine, Vol. III., No. 6, April, 1910.

It must not, of course, be inferred that the isolation of enteric fever cases in hospital has had much, if any, influence in reducing the number of cases directly due to the consumption of shellfish. But it will be generally admitted that this practice may have exerted a considerable effect in reducing the number of secondary cases which might otherwise have arisen in connection with primary shellfish cases.

Up to recent years the most common cause of the prevalence of enteric fever has been regarded as a polluted water-supply, but as during later years other causes, such as shellfish, the conservancy system of excrement disposal, the influence of flies and of "carrier" cases, have been investigated and water-supplies improved, the relative proportion of enteric fever attributed to polluted water-supplies has undergone diminution.

In the case of the towns dealt with in this chapter the influence of contaminated water can in the majority of instances be practically excluded, although there are a few where the water-supply is still such that in a detailed scrutiny of local enteric fever etiology, the question of water causation would have to be very critically examined.

But until more progress has been made in etiological investigation in the sense discussed in the next chapter, reflection upon the precise share taken by one or another of the factors above referred to, in causation of enteric fever is, in the majority of instances, a somewhat difficult task.

In the meantime the fact remains that the consumption of polluted shellfish is a potent cause of enteric fever in this country.

There is another interesting point revealed by a study of the above table, and that is the rise in the enteric fever death-rate, which in the majority of instances took place between the years 1893 and 1901. This phenomenon is especially noticeable in the case of Belfast, where, as Dr. Darra Mair has shown, there was a quite remarkable rise in 1897-1901, attributed to the breakdown of the shoot which conveyed the sewage of Belfast into Belfast Lough, the escaping sewage giving rise to a much greater pollution of the shellfish beds than had been the case formerly. Here the enteric fever death-rate rose to the unique elevation of 200 per 100,000.

In all the other towns embraced in the table the rise in the enteric fever death-rate was much smaller than in the case of Belfast; but attention may be directed to the marked elevation which occurred in Yarmouth, Grimsby, and Sheffield in 1898-9, in Portsmouth in 1899-1900, in Bolton in 1895-6, and in Rhondda and Sunderland in 1893. These elevations are brought out much more distinctly upon charts than upon a table, but it has not been found practicable to reproduce the charts which had at considerable trouble been prepared.

Attention may also be drawn, among the towns in Division 1, to the very low enteric fever death-rate of Brighton and, among those in Division 2, to the low rates in Bristol, Leicester, and Newcastle. Among the still persisting high rates in Division 1, mention may be made of Grimsby, Manchester, Portsmouth, and Belfast, and in Division 2 of Bolton, Nottingham, Preston, Rhondda, St. Helens and Salford.

CHAPTER IX.

The need for more Detailed Investigation into the Etiology of Individual Cases of Enteric Fever before the Precise Amount of that Disease due to Shellfish Ingestion can be ascertained.

In making inquiries for the purpose of this report, the fact has forced itself prominently to the front that if the true measure of the harm wrought by shellfish is to be properly assessed, greater medical assistance must be accorded to the medical officers of health of the larger towns than is at present the case.

It is obviously impracticable for the medical officers of health of many of these towns themselves to make detailed inquiry into the history of every case of enteric fever which occurs in their districts, and unless an assistant medical officer of health, with some experience of etiological investigation, is available for inquiries such as these, it is improbable that the real cause of any material proportion of the cases of enteric fever in any given locality will be ascertained.

This is more particularly liable to be the case with the poorer classes, amongst whom shellfish-borne enteric fever is most likely to occur. None but those who have had experience of etiological investigation involving detailed individual inquiries into the doings of patients during the month preceding the occurrence of enteric fever can appreciate the difficulty of arriving at the truth, and, without some knowledge of epidemiological problems, it is difficult to assess at their proper value the several data brought to light. Numerous medical officers of health have drawn attention to these difficulties, and, until more professional assistance is available, advance in etiological investigations will not be so rapid as could be wished.

Dr. John Robertson, medical officer of health of Birmingham, speaking at the Epidemiological Section of the Royal Society of Medicine in May, 1909,* pointed out that the reason why shellfish had not until recent years been noted as an important cause of enteric fever, was the fact that reliance in the majority of large towns had to be placed upon inquiries made by a sanitary inspector, who is seldom able to obtain information first hand from the patient until such patient has recovered from his illness.

Medical officers of health have found on cross-examining patients at the termination of their illness, that it has often been possible to obtain a definite history of shellfish consumption which may formerly have been denied.

As Dr. Nash has pointed out, inquiries into histories, as regards shellfish, have at times to be conducted with great forensic skill, and he has sometimes found that the question "When did you eat the shellfish?" has elicited the truth, when less direct or non-leading methods would have failed.

Dr. Horne, medical officer of health of Stockton-on-Tees, in answer to some inquiries made by me, states that from time to time he has had suspicion that enteric fever in Stockton has been due to shellfish, but that it is only recently that the facts ascertained have left no doubt on his mind.

He adds that not infrequently it has only been by close personal inquiry of the patient himself, while in hospital, that he obtained admission of the fact of eating mussels within the incubative period of the disease.

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* Proceedings of the Royal Society of Medicine.

Dr. D. S. Davies, medical officer of health of Bristol, tells me that he finds some people who formerly denied eating shellfish, subsequently admit that it was their general custom. He expresses the opinion that such initial denials are due to some confused notion in the minds of the uneducated that they will incur liabilities under the Public Health statutes if they admit anything in regard to the spread of fever. Whatever may be the explanation, the difficulty of arriving at the truth in etiological investigation amongst the humbler classes is undoubted, and it may be due in some degree to the suspicion with which all inquiries are regarded by those whose pecuniary margin is a small one.

It is unnecessary to furnish further illustrations, as the need for more detailed investigation in individual cases is accepted by all medical officers of Health, and the matter is only drawn attention to here in order to bring home to the public the need for more medical assistance if the real magnitude of the amount of disease caused by shellfish is to be properly worked out. It is clearly essential that in all cases not only shall the fact as regards the consumption or non-consumption of shellfish within the incubation period of the disease be ascertained, but also that detailed attention shall be given to the other raw foods which the patients have consumed, as well as to the question of exposure to other conditions or causes which are believed to promote attacks of enteric fever.

Further, it is of the greatest importance that every effort should be made to determine through the retail and wholesale dealers the source of the suspected shellfish, and in this connection the necessity for the registration of all shellfish hawkers, of retail and wholesale dealers, and also of shellfish beds and layings should be brought about.

CHAPTER X.

Seasonal Variations in the Mussel and Cockle Supply and the relation thereto of Enteric Fever Prevalence.

Variations in the Mussel and Cockle Supply.

It is proposed to discuss here whether the variations in the supply of mussels and cockles at one or another season of the year are of such a constant character as to furnish a sufficiently reliable basis for inferences in an epidemiological sense.

The question, as will be seen shortly, is somewhat complicated by the existence of different practices as regards close times in the various Sea Fishery Districts, as well as by the supply of shellfish from other parts of Great Britain and from abroad.

Mussels.

In the first place, as regards mussels, the observance of a regulated close time varies very materially in the different districts.

For example, in the Lancashire and Western Sea Fisheries District, which embraces all the important shellfish centres on the west coast and in which administration is of a high order, the mussel season begins on September 1st and extends to the end of April, that is to say, the mussel season embraces mainly the autumn and winter months. But even in this district, in so far as Barmouth and Aberdovey are concerned, the mussel season does not open until the beginning of November, *i.e.*, two months later than in the remainder of the joint district.

In the Eastern Sea Fisheries District the mussel season has the same duration as in the Lancashire and Western, while in the Glamorganshire District it begins a month earlier, *i.e.*, in August.

Now since, as has been said, the Lancashire and Western and the Eastern Districts comprise between them all the more important home centres of supply, such as Morecambe, Conway, Boston, and Lynn, it is clear that such sources are cut off from supplying the market from May to August inclusive, *i.e.*, during the summer.

But, on the other hand, in the Northumberland, North-Eastern, Kent and Essex, Southern, Devon and Cornwall Districts there is no legal close time, and therefore any or all these districts may, in so far as legal objections are concerned, serve as sources of supply during the summer season. Moreover, the fact remains, that during any time of the year mussels may be introduced into England from Ireland, Scotland, Holland, or other countries. But although this is the case in so far as the law is concerned, it may be said generally that during May, June, and July, and largely also in August, the supply of mussels is very materially reduced, and that, generally speaking, but few mussels reach the market from English or Welsh sources.

By way of illustrating the variations in amounts of the mussel supplies during the open months, the Lancashire and Western Sea Fisheries Committee has been good enough to furnish me with a return showing for each place in the combined district the monthly yield in cwts. and the value in pounds sterling of mussels, and from this return I have constructed the following table:—

Weight and value of Mussels landed in Lancashire and Western District from October, 1906, *to September,* 1908 (*inclusive*).

——	1906.		1907.		1908.	
	Cwts.	£	Cwts.	£	Cwts.	£
January	...	...	14,723	1,448	12,671	1,238
February	...	...	11,808	1,169	10,882	1,068
March	...	...	9,418	980	9,073	902
April	...	...	4,322	398	5,254	620
May	...	...			202	15
June	...	...				
July	...	...				
August	...	...				
September	...	...	15,819	1,509	16,277	1,679
October	23,136	2,313	19,423	2,028		
November	18,258	1,929	17,789	1,765		
December	13,627	1,367	12,063	1,244		

For the two years in question, 214,745 cwts. were despatched. and the amount yielded £21,672.

In so far as the above figures go, it would seem that the heaviest supplies are in the months of October, November, September, January, December, and February, in the order named, and therefore the influence of shellfish, *quâ* disease, should be great during the whole of this period; and it will be well to bear this point in mind.

But if the mean figures for Morecambe for the years 1903-4, 1904-5, 1906-7, and 1907-8 be taken, as furnished by Dr. J. Travis Jenkins in his report for the quarter ended 31st December, 1907, the months in order of magnitude of despatch of mussels are October, November, December, January, February, and September. In other words, the evidence agrees as regards October and November but not with respect to September.

As an illustration of the quantity of mussels imported from abroad, reference may be made to the information furnished by Mr. G. H. Baxter to the Royal Commission on Sewage Disposal in 1903:—

——	Tons.	Total in Market.
1900.		
Mussels received from South Holland—Baxter & Son ...	1,495½	2,900
,, ,, North ,, ,, ...	54½	100
1901.		
Mussels received from South Holland—Baxter & Son ...	1,176	2,300
,, ,, North ,, ,, ...	48	95
1902.		
Mussels received from South Holland—Baxter & Son ...	450	850
,, ,, North ,, ,, ...	47½	90

It may also be pointed out, that of the South Dutch mussels referred to, some were imported during every month of the year except May and June, the number of bags in 1901 being as follows:—

January	1,435
February	1,088
March	1,174
April	375
May	Nil.
June	Nil.
July	573
August	2,126
September	3,940
October	2,554
November	2,481
December	1,345

Here the maximum supplies were furnished in September, October, November, August, January, December, March, and February; the chief point being that in the month of August considerable supplies of mussels are obtained from this source.

Cockles.

With respect to cockles, there is no statutory close time over any portion of the English or Welsh littoral, nor is there any legal prohibition to their importation from abroad at any time of the year.

But although this is so, there are certain circumstances, natural, social, and climatic, militating against the supply of cockles during the summer months.

In the first place, the reproductive processes of the cockle are in activity during the months of May, June, and July: and, in the second place, it is found that the hot weather, which tends to prevail during the summer months, is not conducive either to long transit or to the storage of shellfish. Finally, those who during the winter months are engaged in the shellfish industry find different and perhaps more lucrative occupation in pursuit of fish other than the molluscs, in pastimes associated with the presence of visitors, or in hay harvesting or other agricultural operations inland.

The following table, for which I am also indebted to the officers of the Lancashire and Western Committee, brings out the variations in the cockle supply during the open season (see also page 235, Chapter XIII.):—

Lancashire and Western Sea Fisheries Joint Committee.

Weight, in cwts., and value of cockles landed at all ports in the above district from October, 1906, to September, 1908, inclusive:—

——	1906.		1907.		1908.	
	Cwts.	£	Cwts.	£	Cwts.	£
January	...	...	7,074	816	8,594	1,002
February	...	...	5,737	668	8,176	912
March	...	...	5,624	626	7,850	894
April	...	...	6,122	689	5,129	592
May	...	...	4,869	556	4,685	534
June	...	...	4,350	485	3,064	358
July	...	...	2,990	345	2,842	324
August	...	...	3,896	523	3,677	398
September	...	...	5,215	643	6,646	727
October	6,196	724	8,912	997		
November	7,835	971	11,057	1,249		
December	5,548	644	7,206	831		

That is to say, for the two years covered by the above table, the figures were 143,294 cwts. of cockles, valued at £16,508.

The maximum supply appears to reach the market in the months of November, October, December, January, and February, and it is during these months that cockles must be thought of as exercising their maximum influence upon the human economy, whether for health or disease. These figures agree almost entirely with those furnished by Dr. Jenkins for the years 1905, 1906, and 1907.*

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* Report of the Superintendent of the Lancashire Sea Fisheries District (J. Travis Jenkins, D.Sc., Ph.D.) for the quarter ending 31st December, 1907.

The Seasonal Prevalence of Enteric Fever and the relation thereto of Shellfish Consumption.

Although it is not practicable in this report to discuss the several theories which have been from time to time put forward in explanation of the seasonal prevalence of enteric fever, some reference to the subject is necessary if any attempt is to be made to assess the real mischief wrought by shellfish.

As is well known to all epidemiologists, infectious diseases such as diphtheria, scarlet fever, small-pox, measles and many others vary in prevalence at different periods of the year. Some are what may be termed cold-weather diseases, of which small-pox is an example; others, such as cholera and autumnal diarrhœa, are what may be called warm-weather diseases. Some diseases have but one maximum prevalence in the year, others have two maxima.

The whole question of the seasonal prevalence of disease is but very imperfectly understood, but up to the present time such prevalences have been regarded as being matters rather of natural history than of social circumstances—matters, that is to say, akin to the seasonal prevalence of certain flowers and fruits rather than to the changing habits of the people during each annual cycle.

It may in passing be noted that the organism which is held to be one of the essential factors in causation of enteric fever, belongs to the vegetable kingdom, and that hence it may be supposed to be influenced in somewhat similar fashion to other vegetable organisms. If, therefore, the seasonal curves of certain vegetables be due to seasonal and climatic influences, it would seem *a priori* probable that the same law holds good for vegetable micro-organisms, although in the case of disease-producing parasites the condition of the host at different periods of the year has also to be held in view.

But be this as it may, the more detailed inquiries which have in recent years been directed to the elucidation of epidemiological problems are leading to the conclusion that social habits and circumstances may exert more influence upon the seasonal prevalence of certain diseases than was formerly suspected.

For instance, a study of the seasonal prevalence of diphtheria has led to the belief that compulsory school attendance has, at least in London, exercised a detectable influence upon the seasonal curve of this disease, and it will be seen directly that not improbably the social habits of the people are playing a part, at any rate in some localities, in emphasising the seasonal prevalence of enteric fever. But the subject is a very intricate one, and the data at present available, although distinctly suggestive, do not, it will be seen, justify any wide generalisations.

The maximum prevalence of enteric fever in this country is during the autumn months, the maximum death-rate from the disease being two or three weeks later than the maximum prevalence. The curve relative to *notified* cases in London* for the years 1890-1908 shows that the number of cases first rises above the mean line in the 34th week, steadily increases up to the 37th or 38th week, and maintains an elevation which is approximately the maximum from the 40th to the 45th week, when a steady decline ensues which carries the notification curve below the mean line in the 51st week of the year—*i.e.*, at the end of December. The curve continues to decline until April or May, when it is at its lowest, the annual rise commencing in June or July.

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* Annual Report of the Medical Officer of Health of the County of London for the year 1908.

The month of maximum prevalence in the Metropolis varies only within narrow limits. For example, from 1891-1907 (seventeen years) the maximum was reached six times in September, six times in October, four times in November, and once in December, that is the range over which the highest peak works is about four months. It is of interest, also, to note from a diagram furnished by Sir Shirley Murphy to the Royal Commission on the Treatment and Disposal of Sewage that the period at which the prevalence curve passes above the mean line varies markedly not only as regards its time of passage, but also as to its manner of transit.

Twice (in 1893 and 1902) it passed the line in June, twice (1899 and 1901) in July, four times in August, and three times in September.

Similarly there are marked varieties in the rate and range of the decline of the curve; sometimes it is sudden and decisive, at others it is gradual and halting.

The more important theories which have from time to time been put forward in part explanation of the seasonal prevalence of enteric fever are associated mainly with what are directly or indirectly certain conditions of the soil.

Pettenkofer and Buhl, in so far as the city of Munich in Bavaria is concerned, traced a connection between the oscillations of the subsoil water and the prevalence of enteric fever, and as Hirsch expresses it in his "Geographical Pathology":—

"The total of the cases of sickness and death from typhoid falls with the rise of subsoil water and rises with the fall of it; . . . the level reached by the disease is not in proportion, however, to the then level of the subsoil water, but only to the variation in it on each occasion, or, in other words, it is not the high or low level of the subsoil water that is decisive, but only the range of fluctuation."

These researches have been confirmed by experimental observations in Berlin and other parts of Germany, but the association referred to does not appear to hold good for this country, while, as regards Austria, Fodor's work led him to a conclusion opposite to that of Pettenkofer. It was suggested by Buchanan that when the prevalence of enteric fever rose after a rapid fall of ground water following upon a rapid rise, such prevalence might be brought about by the falling water carrying specific impurities into the wells.

There is also some evidence pointing to the conclusion that the seasonal prevalence of enteric fever bears some such relationship in time to the temperature of the earth at a depth of 4 feet, as was observed by Ballard in his classical studies relative to autumnal diarrhœa.

Within recent years, too, considerable attention has been paid, especially by Niven, Hamer, Nash, and others, to the habits and natural history of the domestic fly, and investigations are being made to determine what relation, if any, the diffusion of these insects bears to the seasonal prevalence of enteric fever.

An instructive preliminary study relative to the question of the seasonal prevalence of disease was brought before the Epidemiological Section of the Royal Society of Medicine by Dr. Owen H. Peters in the autumn of 1908.* The author, on the basis of researches with reference to the circumstances of Nottingham and London, showed that the curves relative to the seasonal prevalence of enteric fever and diarrhœa, as well as the curve relating to the time of the wheat harvest, manifested a remarkable parallelism to the temperature of the air and to the temperature of the earth at a depth of 1 foot.

Dr. Peters showed:—

1. That the time of the epidemic or seasonal rise of the diarrhœa and enteric fever curve varies considerably in different years, the rise for both these diseases being ten weeks later in the latest than in the earliest year.

2. That the time of attainment of summer temperature also varies very widely in different years.

3. That when the diarrhœa and enteric fever curves are compared with the curve of the development of summer temperature, a very general correspondence is observed between the earliness or lateness of the epidemic rise and the earliness or lateness of the development of summer temperature.

Dr. Peters found that it is not the mere arrival at a certain fixed temperature that is related to the date of the seasonal rise, but the cumulative effect of certain degrees of temperature extending over a certain time.

His theory, in fact, implies *(a)* the maintenance of certain temperatures, *(b)* the existence of a certain period of time, *i.e.*, the point which marks the *main* rise of the seasonal epidemic of diarrhœa or enteric fever marks also the end of a period of several weeks' duration during which the influences of certain summer temperatures were in evidence.

In other words, Dr. Peters furnishes a mass of data pointing to the conclusion that the ripening of the diarrhœal or enteric fever organism requires a long period of development which can be referred, as can also the date of the harvest, to the cumulative effect of temperatures acting throughout each stage of that process.

He likens the seasonal wave of each of these two diseases to the completion of the life-cycle of two plants with a much shorter period of growth, and requiring slightly higher temperatures, than the wheat plant, and the charts which he furnishes show a remarkable parallelism year by year between the temperature and diarrhœa and enteric fever curves. The scope of this work does not allow of further reference to any of the foregoing theories, and it is now necessary to consider in what manner, if at all, the seasonal prevalence of enteric fever may be influenced by the consumption of shellfish.

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* Proceedings of the Royal Society of Medicine, Vol. II., No. 1, November, 1908. Longmans, Green & Co. Price 7*s.* 6*d.* net.

Attention may first be directed to an important general consideration.

In the event of shellfish being a dominant factor in promoting or maintaining the seasonal prevalence of enteric fever which, as Murchison remarks, is probably identical with the " autumnal fever " observed by Sir John Pringle and Rutting in Britain and Ireland during the seventeenth century, it might possibly be shown, were the necessary data at hand, that before the general diffusion of shellfish over the country through the medium of railways, either the autumnal rise was absent, or it was less emphasised than at the present time.

Unfortunately, however, notifications are only available since 1890, and the disease itself was only separately grouped in 1869 in the reports of the Registrar-General.

But there is to be found in Murchison's classical treatise a table relative to the monthly admissions during thirty-five years into the London Fever Hospital as well as the admissions in the quarters and seasons of each year.

From this table the fact is brought out clearly that the largest number of cases was admitted during the autumn months of October, November, September and August, in the order given, and the smallest number of admissions took place in April, May, February and March. In the two months, October and November, 27·7 per cent. of the total for the year were admitted, the percentage for April and May being only 7·3 per cent. Moreover, it is of some interest to note that the autumnal rise was observed in each of the thirty-five years in question with the notable exception of the year 1860, when owing—Murchison thinks—to the remarkably cold and wet summer and autumn the admissions into the London Fever Hospital fell to one-half of the average for the previous twelve years, such diminution being due to the *absence of the ordinary autumnal increase*.

It would seem also that the observations made over the period to which Murchison refers showed the same autumnal increase on the Continent, whether regard be had to Switzerland, France or Germany, and at that time a similar condition of affairs appears to have obtained in America.

The above considerations would appear to have a not unimportant bearing upon the question of the degree of the relation of shellfish to seasonal prevalence in that they may perhaps be held to indicate that the same forces, whatever they may be, which are now operative in promoting seasonal prevalence of enteric fever, have been operative since enteric fever was classed by the Registrar-General as a separate entity.

But there have now to be considered certain data which, taken together, seem to suggest that, at least in certain localities, shellfish may be operating as important contributory agents in maintaining or modifying the seasonal prevalence of enteric fever.

In evidence given before the Royal Commission on Sewage Disposal in July, 1903, Sir Shirley Murphy adduced data pointing to the conclusion that in respect to the year 1902 some 8·4 per cent. of the total enteric fever cases in London may have been due to shellfish consumed within the incubation period of the disease, and some instructive diagrams then furnished by him to the Commission relative to enteric fever in London, in each month of the year 1902, went to show that had shellfish not been operative to the extent estimated by him there might have been some slight modification of the seasonal prevalence of enteric fever in London during that year. He expressed the opinion that the figures furnished relative to the number of shellfish-borne cases were rather under than over the mark; and his annual report for the year 1908 shows that 18·5 per cent. of the enteric fever cases notified had eaten shellfish at a time consistent with the hypothesis that such shellfish may have been the cause of the illness.

Dr. Nash has investigated this question as regards Southend, and he has constructed a chart for the years 1895 to 1901, which shows that during August and September the monthly mean incidence of enteric fever, as measured by the notifications for that period, rose from 40 per cent. below the monthly mean in July to 30 per cent. above it in August, and 190 per cent. above it in September. In explanation of such behaviour he draws attention to the fact that during the latter end of July the cockle season comes into full swing in Southend, reaching its height in August and September. Oysters (referring presumably to English natives) are, he adds, in season in Southend from about the middle of August, and are extensively consumed, and coincident with this there is the seasonal occurrence of enteric fever. Towards the end of September the seaside season begins to wane, and early in October it is over, nearly all the shellfish shops closing until the following year. He points out that immediately there is a marked drop in the incidence of enteric fever, until in December it is almost at the mean level.

With this chart relative to the Southend notifications for the six years 1895-1900, he compares the mortality curve for London for the years 1869-1890, which shows that the deaths from enteric fever reached their maximum in the latter part of October and early November, as compared with a notification maximum for Southend (for 1895-1901) during September. From about mid-November the London death curve declines, and about mid-January passes below the mean level. Dr. Nash suggests that the increase of deaths in August is to be largely accounted for by the return of Londoners who were away in July, and he thinks it probable that a large proportion of these cases have indulged in shellfish while at the seaside. The September rise, he thinks, may be due to the continued return of shellfish-eating visitors, while the fact that the death curve has not yet reached its zenith he attributes to the circumstance that the local shellfish trade is at this time transferred to London, where during October and November oysters are freely consumed at the dinners which take place at that season.

There would seem little doubt that in Southend the influence of shellfish during the period to which Dr. Nash relates was very great, more especially when the result of Dr. Nash's other valuable investigations, as regards the shellfish-eating community in Southend, are taken into account.

The question as regards the influence of shellfish upon the seasonal prevalence of enteric fever in London is, of course, a very difficult one, and the necessity, in absence of the notification dates for London for 1869-1890, of comparing the Southend notification curve with the death-rate curve for London, tends somewhat to accentuate the difference between the two curves. If reference be made to the notification curves in London, in the annual reports of Sir Shirley Murphy, it will be seen that in 1896, 1901, 1902, 1904, and 1905 the zenith was reached in September. There is further the question as to how far the people who take residential seaside holidays are in the habit of eating shellfish other than native oysters, which, as Dr. Nash points out, are out of season until August 5th, and, with reference to the suggestion as regards the influence of the winter dinners in the Metropolis, it would be instructive to ascertain the class incidence of enteric fever in London about that period. So far as my own inquiries go, they tend to the conclusion that the London enteric fever is largely a disease of the very poor, but there is difficulty in procuring convincing evidence upon this point.

The fact, as shown by Sir Shirley Murphy's diagrams, that there is considerable variation year by year in the seasonal prevalence of enteric fever in London, does not quite fit in with the view that the holiday months have a very decisive influence upon the prevalence of the disease, and the investigation of Dr. Peters, to which reference has already been made, shows that there may be an interval of as much as ten weeks between the earliest and latest enteric fever prevalence.

Dr. Nash has also drawn attention to the behaviour of enteric fever in certain other towns, such as Ipswich, Yarmouth, Liverpool, and Edinburgh, and his observations thereon will be found distinctly suggestive.

At the time of my visit to Yarmouth in connection with this inquiry, Dr. Beach, the medical officer of health, furnished me with a table of the monthly notifications of enteric fever for several years past, and Dr. Pringle, medical officer of health of Ipswich, has kindly sent me similar figures for that town.

The study of these two tables is of interest, since that for Yarmouth may be thought of as being modified by mussel consumption, that of Ipswich mainly by cockle consumption.

In the case of Yarmouth the maximum incidence of enteric fever for the period covered by these tables occurs in October: in Ipswich in September.

But the most instructive point is the striking differences in quarterly incidence which, in the case of Ipswich, is in the third quarter, in the case of Yarmouth in the first quarter, the incidence in this latter case upon the first and last quarters being almost equal, and in each case greatly in excess of that in either the second or the third quarter.

Monthly Notifications of Enteric Fever in Ipswich from 1898-1909.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Whole Year.
1898	2	—	2	—	2	—	3	6	11	19	15	7	67
1899	7	4	2	9	3	6	14	27	88	87	21	13	284
1900	5	5	4	1	5	1	6	12	17	14	14	8	92
1901	1	3	2	—	1	—	5	7	5	11	19	8	62
1902	3	5	4	4	7	17	39	25	37	16	14	2	173
1903	2	4	1	2	2	4	2	4	6	5	7	6	45
1904	3	5	3	5	4	5	2	5	9	6	2	1	50
1905	—	—	1	3	9	3	5	19	3	4	2	1	50
1906	—	1	—	2	3	3	1	4	7	11	4	—	36
1907	1	1	1	1	1	6	6	3	5	—	6	2	33
1908	—	—	—	1	2	2	5	3	2	—	—	—	15
1909	—	3	—	—	—	2	3	—	5	1	1	—	15
Totals for month 1898–1909 ...	24	31	20	28	39	49	91	115	195	74	108	48	
Quarterly totals 1898–1909 ...	75			116			401			330			922

The Yarmouth table might be regarded as indicating that a large quantity of mussels has been, especially in the earlier years, consumed during the winter months, and the table as a whole shows that the greatest prevalence of enteric fever was incidental to these months—September to March—when mussels are regarded as being in season and when—in such districts as have byelaws relative to the matter—a close season is enacted.

Indeed, the Yarmouth enteric fever curve would seem to have corresponded more nearly to the mussel season than is the case in any other town wherein the relations have been observed.*

Monthly Notifications of Enteric Fever in Yarmouth from 1895-1909.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.
1895	10	5	6	1	6	5	7	10	31	28	21	20	150
1896	19	23	26	6	4	2	1	6	12	7	11	10	127
1897	16	17	11	2	7	3	5	15	10	15	15	15	131
1898	25	38	32	17	16	7	8	9	13	26	28	25	244
1899	40	25	3	3	3	4	2	6	25	7	4	9	131
1900	5	5	2	2	5	3	2	9	10	52	23	5	123
1901	3	9	16	18	5	4	4	3	8	12	4	1	87
1902	3	5	3	2	1	0	4	5	8	2	3	2	38
1903	2	4	3	4	2	2	0	1	6	2	1	1	28
1904	5	2	3	1	1	1	0	15	19	7	9	1	64
1905	1	4	6	6	1	0	1	5	2	7	3	2	38
1906	3	1	7	12	4	1	2	1	8	1	4	1	45
1907	0	3	10	13	2	0	0	3	1	4	1	0	37
1908	3	1	6	3	2	1	2	4	2	2	6	3	35
1909	6	5	5	1	3	3	3	1	5	1	1	1	35
Totals for month 1895–1909 ...	141	147	139	91	62	36	41	93	160	173	134	96	
Quarterly totals 1895–1909 ...	427			189			294			403			1313

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* The drop in December is remarkable and indicates perhaps that mussel eating at Christmas has fallen into desuetude.

But in the case of Ipswich the greatest incidence has been in the months, when it has until recently been the local practice to consume raw cockles collected from an area of the Orwell estuary which is subject to pollution. (*See* page 164.)

Reference will be made directly to the case of Belfast where the evidence strongly supports the view that cockle-eating has caused a large amount of enteric fever.

It will be also noted that in the case both of Ipswich and Yarmouth there has been a very substantial decline of enteric fever during about the last five years.

	Yarmouth (1895-1909).	Ipswich (1898-1909).
January	141	24
February	147	31
March	139	20
April	91	28
May	62	39
June	36	49
July	41	91
August	93	115
September	160	195
October	173	174
November	134	108
December	96	48

It might, in fact, be suggested that in some towns the influence of mussels can be detected on the enteric fever curve, while in others it is the cockle influence which is apparent, the former manifesting its effects in the late autumn and winter months, the latter more in the late summer months; but the evidence is as yet too slender to generalise upon.

This subject of shellfish influence upon seasonal prevalence has been approached in somewhat different fashion by Dr. Niven of Manchester in his annual report for 1907. Dr. Niven points out that mussels are consumed in Manchester during the close season, a statement which can certainly be extended to many other towns; indeed, it is important to appreciate the fact that a legal close season for mussels only obtains in those Sea Fisheries Districts for which definite byelaws upon the subject have been made (*i.e.*, Lancashire and Western and the Eastern) and that in the greater number of such districts there are no byelaws relative to this point. But, notwithstanding this, it is a fact that during May, June, and July, and largely in August also, but few mussels from home waters reach the market. In so far as Manchester is concerned, Dr. Niven states on the basis of individual enteric fever cases and as a result of visits to the shellfish shops, that although mussels are consumed in Manchester during the close season the supply of these mussels is greatly reduced and comes at that time chiefly from Ireland (where it may be added there are (or were until recently) numerous beds liable to pollution).

It is added that the evidence available in Manchester suggests that from September to Christmas the daily supply amounts to

500 to 1,000 bags averaging 1 cwt. each, while from Christmas to the end of April the supply amounts to only about half that amount (averages which are no doubt liable to considerable fluctuation).

It is there pointed out that during September the Manchester market is liable to be glutted with mussels, large quantities going bad and being condemned.* It is inferred that this rush of mussels in September may be held to be likely to augment the risk of mussel-born enteric fever, and the fact is drawn attention to that if the amounts coming from contaminated layings vary directly as the total sources of supply there should be not much more than half the number of mussel associated cases of enteric fever in the period May to September compared with the period September to January.

Now the actual number of mussel associated cases for the years 1897-1901 were respectively 15 and 31, while for each of the more recent years the numbers were as follows:—

January to May.	Year.	September to January.	May to September.
8	1903	19	5
12	1904	22	1
42	1905	35	4
January to April.	**Year.**	**October to January.**	**April to September.**
37	1906	37	2
6	1907	44	17

and Dr. Niven points out that in the years 1905 and 1906 the cases were not distributed in proportion to the reported amounts sold.

It is impracticable to follow step by step the detailed analyses of Dr. Niven in his successive annual reports, and it will be best to furnish his latest conclusions in his own words as set forth in an exhaustive contribution on "Summer Diarrhœa and Enteric Fever," read before the Royal Society of Medicine on April 7th, 1910:—

"In Manchester, with sufficient energy and skill, the probable origin of most cases of enteric fever can be determined, in some years at all events, in terms of 'mussel' and 'contact' infection. 'Contact' infection and 'mussel' infection cases are proportionately least numerous prior to the thirty-eighth week of the year, before which period the enteric fever curve begins to ascend. This ascent, which cannot be due to either of the two causes for the continuation of enteric fever which have been named, may be due to transference of infection by flies."

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* Apparently the quantities of mussels received in Manchester do not quite correspond with the quantities leaving the chief mussel beds on the Lancaster littoral.

A highly suggestive contribution to the study of the question of shellfish influence in relation to the local seasonal prevalence of enteric fever is contained in the paper which my colleague Dr. Darra Mair read before the Epidemiological Section of the Royal Society of Medicine in the spring of 1909. (*See* p. 39.)

In this paper Dr. Mair furnished a chart based upon the notifications of enteric fever during each week of the years 1897-1906, the mean line representing 48·8 notifications per week.

This chart shows that for Belfast the notification curve is at its minimum about January and February, that in March a rise has occurred which is maintained through April, while early in May there is an ascent above the mean line which continues until mid-June, when after a curious little depression late in July, what may be termed the autumnal elevation commences, which reaches its highest level in late August and early September, after which a decline sets in which causes the curve to fall below the mean line as early as the end of October. With this curve, which may provisionally be regarded as a cockle curve, Dr. Mair constructs the curves for Manchester and for London. That for Manchester, which is perhaps to be thought of as in a measure a mussel influence curve, relates to the same period as the Belfast curve, *i.e.*, 1895-1906, and there is between these two curves a marked dissimilarity.

In the Manchester curve there is for the first four weeks of the year a distinct rise, the curve being above the mean line. In the fifth week there is a decided drop and the curve declines, with the exception of an elevation in April, until July, when the autumn elevation begins passing over the mean line about mid-August, reaching its highest point in late September and mid-October, and passing below the mean line at the end of the year, two months later than the Belfast curve. It may here be noted that Dr. Niven as the result of an elaborate examination of the behaviour of enteric fever in Manchester regards shellfish as exercising a material influence upon the behaviour of the seasonal curve in that city. The London curve, which is for 1890-1907, does not differ very materially from that of Manchester except that the January rise is absent. Here again Sir Shirley Murphy's investigations may be taken as supporting a view that the seasonal prevalence of enteric fever is somewhat modified through the consumption of shellfish.

One of the most striking features about the Belfast curve is the elevation in May and June, and, by way of throwing further light upon this as also upon the autumnal rise, Dr. Mair has divided the period 1897-1907 into two—1897-1901 and 1902-1906. The latter period corresponds to the time during which there was a marked decline in the disease and steps were taken to prevent the consumption of cockles.

The result of this contrast is to show that during the latter period the autumnal prevalence has almost entirely disappeared, and this same phenomenon is still more apparent from a study of the separate curves for the years 1906-8 respectively, by far the heaviest incidence for 1906 being in the first quarter of the year.

Dr. Buchan, medical officer of health of Heston and Isleworth and late assistant medical officer of health of Birmingham, has recently made an investigation into the relationship between mussels and enteric fever in Birmingham between June 1st, 1904, and June 1st, 1909. Systematic enquiries are made into every case in the city in accordance with a scheme devised by Dr. Robertson, the medical officer of health, and the etiology of the 855 cases of enteric fever which occurred between the dates referred to are thus summarised:—

Cases probably due to personal contact ...	33
,, ,, ,, mussels	124
,, ,, ,, other shellfish ...	32
,, ,, ,, watercress ...	5
,, of unknown origin	661
	855

Dr. Buchan furnishes a curve relative to the seasonal prevalence of enteric fever in Birmingham during the years under consideration, and the cases have been plotted out according to their weeks of commencement. By adding together the cases commencing in corresponding weeks in successive years, and by differentiating those probably due to mussels from those probably due to other causes, it appears that with negligible exceptions the first mussel cases had their onset in the 37th week, *i.e.*, about a fortnight after the mussel season begins, and after this the number of mussel cases commencing in any given week rapidly rises to a maximum about the 43rd week, remains fairly constant after the 50th week, and then slowly declines, the last mussel cases occurring in the 20th week, about a fortnight after the mussel season ends. This curve agrees closely, Dr. Buchan states, with the number of mussels imported into Birmingham, which after rapidly rising to a maximum at the commencement of the season, in September, and remaining fairly constant until after Christmas, gradually falls until the close of the mussel season on April 30th. As this chart shows, mussels would appear to account for a not inconsiderable portion of the autumnal rise of enteric fever.

But, as will be seen in Chapter VIII., in many of our large towns such, for example, as Bristol, Newcastle, Nottingham, Sunderland, Cardiff, Salford, Preston, Liverpool, and Leeds, in many of which there is apparently a well-marked seasonal curve, it is reported by the medical officer of health that shellfish exert very little, if any, influence in production of enteric fever, and in face of this testimony there must at least for the present be abstention from general inferences.

It has, too, been shown in Chapter X that very large quantities both of mussels and of cockles are reaching our town population during September, October, November, December, January, and February, and that the difference in the amount month by month would not seem quite to fit in with the decided elevations and depressions of the enteric fever curve. Large amounts of mussels arrive in January and February, and the difference between these amounts and those arriving in September, October, and November is not great enough to account for the marked variations in the number of cases of enteric fever.

It is clearly necessary not to attempt any generalisation at the present juncture. But it is highly desirable that the subject should be studied in relation to each of our large towns when further detailed information is available, not only with regard to consumption of one or another shellfish within the incubation period of the disease but as to other circumstances which may have caused the disease. Efforts should also be made to determine, so far as may be practicable, the proportion which the shellfish-eating part of the community bears to that which eats no shellfish.

The Consumption of Shellfish at School Treats and on Bank Holidays as occasional causes of Enteric Fever.

It is to be anticipated that, given sources of shellfish supply liable to specific contamination, the consumption of such shellfish in a raw or imperfectly cooked condition might, at times, cause cases or even outbursts of enteric fever.

Such occurrences may be brought about either by visits to places where polluted shellfish are on sale, or by the introduction of such shellfish into other places.

Instances of visitors to seaside resorts having apparently contracted enteric fever from the consumption of contaminated shellfish are not uncommon, and they have been recorded in connection with school treats at Exmouth and visits to Southend, Southwick, Brightlingsea, and other places.

But it has occurred to me that it might be worth while in the case of London to ascertain how far, if at all, the occurrence of the two Bank Holidays—Easter and Whitsuntide—on each of which large quantities of shellfish—mainly, cockles—are consumed, have been followed by suspicious or marked increase of enteric fever in any of the three weeks following the week in which Easter Monday or Whit-Monday occurs.

Dr. Hamer, who had already got out the figures, has kindly furnished me with a table showing the enteric fever notifications, week by week, in London. As probably the bulk of the shellfish purchased at these festivals are consumed on the Bank Holiday itself or the Sunday preceding it, the period of incubation may be calculated from these dates. This being so, it is improbable that any of the cases, theoretically caused by the Bank Holiday shellfish, would be actually notified either in Bank Holiday week or in the week immediately following it, and it is perhaps to be expected that the greatest number of notifications of cases infected on or about Bank Holiday would reach the medical officer of health in the third or fourth week, Bank Holiday week itself being the first week. But as there may be some difference of opinion as to this inference, the figures for each week are furnished in order that any individual theory may be applied:—

Number of Cases of Enteric Fever notified in EACH WEEK *in London during the* 10 *years* 1899-1908, *Easter and Whitsun weeks being printed in leaded type.*

No. of Week.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	
1	63	95	104	48	45	36	26	23	23	13	
2	81	89	65	49	44	39	25	23	32	25	
3	75	93	71	39	35	32	23	17	35	23	
4	88	102	78	40	50	24	33	27	26	30	
5	63	84	52	34	33	25	32	28	30	27	
6	79	69	64	37	44	31	20	21	27	13	
7	78	77	61	48	18	18	23	18	28	11	
8	58	78	46	43	31	37	21	30	22	17	383
9	55	84	42	47	37	26	12	20	18	22	363
10	35	62	33	44	21	25	18	29	20	16	303
11	39	65	42	32	21	21	18	20	28	16	302
12	43	61	37	26	28	22	15	17	27	10	286
13	24	62	34	33	27	22	24	21	17	16	280
14	**27**	55	18	**14**	10	**26**	22	23	**29**	21	245
15	34	44	**29**	28	**16**	18	17	16	20	24	246
16	35	**60**	34	26	14	16	17	**15**	22	13	252
17	45	50	36	52	14	18	**28**	19	23	**12**	297
18	31	34	26	49	20	21	19	20	8	11	239
19	20	54	30	29	18	14	22	18	19	12	236
20	25	48	29	43	20	25	27	13	18	11	259
21	**33**	50	29	**37**	27	**18**	25	11	**25**	15	270
22	28	53	**40**	52	**15**	23	30	18	12	8	279
23	51	**48**	40	65	26	27	26	**15**	17	20	335
24	35	66	46	57	33	23	**13**	45	22	**13**	353
25	47	40	44	82	29	16	27	48	19	19	371
26	35	49	48	74	49	19	25	35	23	15	
27	29	38	33	85	34	32	31	20	18	19	
28	36	43	56	78	36	25	29	23	24	19	
29	49	38	64	95	34	21	30	27	14	22	
30	78	46	49	112	37	31	27	28	15	20	
31	77	53	78	68	35	25	42	33	19	20	
32	69	57	77	71	50	39	24	20	14	17	
33	76	52	84	70	59	45	30	25	31	24	
34	81	74	66	59	49	77	42	30	18	25	
35	78	64	109	87	59	59	38	32	32	18	
36	94	74	109	104	60	78	43	49	31	26	
37	136	128	123	127	65	82	55	52	30	31	
38	124	142	135	136	73	68	49	54	41	29	
39	143	149	85	104	94	85	65	39	52	32	
40	175	117	106	100	111	60	48	71	44	50	
41	125	141	83	123	71	50	58	72	38	37	
42	168	127	85	109	67	55	43	43	52	41	
43	199	126	79	89	77	51	51	45	34	33	
44	284	147	90	105	75	58	34	48	29	60	
45	269	179	85	71	66	41	28	39	36	61	
46	177	152	74	72	69	54	42	36	30	44	
47	158	112	81	78	95	35	19	47	32	64	
48	159	128	67	56	83	42	40	49	41	40	
49	131	109	74	71	67	44	22	42	36	53	
50	120	132	43	51	47	52	21	42	37	38	
51	99	101	46	40	49	43	21	23	36	37	
52	93	91	35	55	52	22	32	21	20	26	
53				63						38	
Total... ...	4,454	4,292	3,194	3,407	2,339	1,896	1,552	1,600	1,394	1,357	

Easter.		Whitsun.	
Date.	Week.	Date.	Week.
1899. 3rd April	14th	...	21st
1900, 16th ,,	16th	...	23rd
1901, 8th ,,	15th	...	22nd
1902, 31st March	14th	...	21st
1903, 13th April	15th	...	22nd
1904, 4th ,,	14th	...	21st
1905, 24th ,,	17th	...	24th
1906, 16th ,,	16th	...	23rd
1907, 1st ,,	14th	...	21st
1908, 20th ,,	17th	...	24th

It may be observed that the total period of about 11 weeks, which is covered by both Bank Holidays in the 10 years dealt with, comprises part of the months of April, May, and June, a period, that is to say, when the enteric fever curve is at its lowest and when its oscillations are generally less pronounced than at any other period of the year.

Taking first the case of Easter Monday for the 10 years covered by the table, and allowing an incubation period of about a fortnight, it will be seen that in 1899, 1901, 1902, and 1906—four years—Easter Monday week was followed by a rise in the number of enteric fever notifications. In the remaining six years there was a fall in five instances, and a stationary condition in one. With respect to Whitsuntide, there was an increase in nine instances and a decrease in one; the most suspicious years from the view-point of shellfish being 1899, 1901, 1902, 1903, and 1906.

It is difficult, in the absence of details with regard to individual cases, to draw any very reliable inference from these figures, but in the year 1902 the circumstantial evidence in favour of the view that the increase following Whitsuntide was due to the consumption of Leigh cockles was very strong. As will be seen by the totals in the right-hand column, Easter coincides with almost the lowest prevalence of enteric fever in London, while at or about Whitsuntide such prevalence is on the increase.

So far as I have been able to gather, the weekly supply, from Southend to London, is about 3 tons, whereas in Easter and Whitsun weeks this amount is nearly, if not quite, doubled. Mr. J. Wrench Towse, Clerk to the Fishmongers' Company, informs me that the principal supply of cockles to the London market in the summer months is from Leigh-on-Sea (in a cooked state), whereas in the winter months the supply comes largely from Holland.

As regards the cockles from Leigh, it has to be borne in mind that during recent years these shellfish have been so treated as to effectually sterilise them.

CHAPTER XI.

The Transplantation and Cultivation of Shellfish with a view to removing them from Polluted to Unpolluted Beds prior to their despatch to Market for Human Consumption.

A consideration of this subject is called for owing to the fact that, in the case of certain estuaries and localities where shellfish are found, transplantation is the only means which will save the local industry from the serious consequences which might ensue were the despatch of shellfish from such places entirely prohibited.

In the case of mussels, a considerable amount of work, in the nature of cultivation, has already been carried out, the idea of such culture having arisen many centuries ago on the shores of the Bay of Aiguillon, on the west coast of France, where a shipwrecked Irishman, named Walton, was rescued by the inhabitants of the village of Esnandes in 1235.

Walton possessed the mind of a naturalist, and, among other things, he reared a local breed of sheep by crossing the sheep of the district with some of those which he saved from the wreck. He also invented a form of net—the *alluret*—which he used for catching such birds as skimmed the surface of the mud flats at night. These nets were supported by poles which were fixed in the foreshore mud, and Walton, noting that these poles became covered with mussels, increased the number of poles, and thus commenced what is now know as the *bouchot** or wattle-system of mussel culture.

The system, as carried out by Walton, consisted in arranging rows of poles on the foreshore in V-shaped form, the apex of the V being seaward; the intervals between the poles were bridged with wicker work, and a space was left at the bottom to prevent the silting up of mud. The rows nearest the sea caught the mussel spat, those higher up towards the land were used for growing and fattening the molluscs.

Walton also invented a flat-bottomed boat, which he used for traversing the mud of the foreshore where the *bouchots* were erected; it was known as an *acon*, and similar boats are used at the present time in the industry.

The *bouchot* system, as carried on to-day in France, is in principle identical with that practised by Walton, except that the rows of posts are now arranged parallel to one another and at right angles to the coast-line instead of in a V-shaped form.

The *bouchots* furthest removed from the shore and which are uncovered at low water of spring tides only are called by the "*bouchoteur*" *bouchots du bas*, those near the shore *bouchots batards*, and those which are highest up, which are for the longest period out of water *bouchots d'amont*.

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* A word stated by M. Coste to be formed by contraction from *bootchoat*, an expression derived from a mixture of Celtic and Irish, and signifying a wooden enclosure, *bout* enclosure, and *choat* or *chot* of wood.

The *bouchots du bas* consist of posts only, and may be regarded solely as collectors of spat, and it is from these posts, in or near the month of July when the young mussels are about as large as a haricot bean, that the collectors obtain the supplies of mussels necessary to furnish the landward *bouchots.*

The young mussels are separated from the posts, wrapped in pieces of old netting, and pushed in between the interstices of the wattling; the netting decays and leaves the mussels attached to the wattling.

Attempts have been made in Scotland to establish the *bouchot* system of mussel culture at places such as Montrose, Tain, Inverness, and St. Andrews, but it does not appear from the accounts given of these experiments in the Mussel Bait Commission's report in 1888 that such attempts were attended with any great success. Much difficulty seems to have been experienced from rough weather. More recent attempts have been made off Piel Island, in Lancashire, by the Lancashire Sea Fisheries Committee, but here, again, the exposed position of the *bouchots* was fatal to the success of the experiment.

There is, however, another type of mussel culture which may be spoken of as the "Bed system," and which has met with very considerable success in this country. Succinctly stated, it consists of transferring mussel "brood," when quite small, to sheltered situations in estuaries or creeks, where they are accessible and where they can be carefully tended.

The best illustration of this method is that which is practised in connection with the mussel "scalps" in the Wash, off Boston and Lynn.

Under the regulations of the Eastern Sea Fisheries Committee, no mussels for immediate consumption may be taken from the mussel "scalps" under 2¼ inches in length, but in some years and at certain periods of these years definite "scalps" are thrown open for the removal therefrom of mussel "brood." The young mussels are collected and transferred either by boat or train to the mussel "layings" which abound along the coast of Norfolk, at places such as Brancaster, Wells, and Blakeney.

Hereabouts the channels of the rivers and creeks are divided into strips or, to use an agricultural analogy, allotments by means of beacons or stones, each strip being rented from the harbour or river authorities by a fisherman, who then has the sole right to lay down and collect mussels from the strip or "lay."

A large quantity of these mussels are uncovered at low water, when the lay-holders may be seen on their mussel beds culling over and cleansing their stock.

When the mussels are of marketable size they are collected, and, perhaps, stored higher up on the banks of the creek so as to be accessible to the owners shortly after the commencement of the ebb tide. When actually wanted for market, the mussels are picked over, cleaned, and despatched in bags.

The Norfolk mussel culture industry is an important one, and affords employment to a large number of people.

Within the last two or three years parts of the Wash itself have been set aside in similar fashion for the purposes of laying down mussels, each of the "lays" being marked off by stones or beacons, and possessing areas covered at different states of the tide, so as to afford the layers opportunities for carrying out out all phases of the mussel culture process.

In several parts of the Lancashire and Western District, as well as in the Northumberland and North-Eastern Districts, transplantation of more or less adult mussels has taken place, and, perhaps, the best instance of this is the extensive operations which took place at Morecambe in 1902, and of which an exhaustive account has been written by Mr. Andrew Scott, A.L.S., and Mr. Thomas Baxter, a Member of the Lancashire and Western Sea Fisheries Committee. This transplantation was undertaken with two objects in view:—

(1) to remove large quantities of small mussels from over-crowded beds, leaving the remainder more growing space; and

(2) to re-stock older beds that had been depleted from various causes, or establish new beds on suitable ground, either with the mussels removed from the original site or with others taken from areas altogether unfavourable for growth.

Professor Herdman had for several years advocated in his annual reports this system of mussel thinning owing to the over-production of the beds which had taken place.

In the year 1905 the Sea Fisheries Committee, largely owing to the efforts of Mr. John Fell, its Chairman, resolved to grant £50 to enable the Morecambe fishermen to thin the overcrowded beds, and this sum, together with the willing co-operation of the fishermen themselves, enabled some 200 tons of mussels to be transplanted. The results were regarded as sufficiently satisfactory to justify further work in a similar direction, and in the following year a sum of £75 was voted for re-stocking mussel beds at Morecambe, Overton (in the Lune), and Flookburgh, and of this sum £50 was apportioned to Morecambe. Work extended from April 18th to May 5th, the mussels being removed to the selected places in boats by the aid of some 50 fishermen. The sum paid to each man was 3*s*. per tide, and the deficit on the vote was made up by the Morecambe fishermen's association. In all about 3,174 bags or nearly 200 tons of mussels were removed from certain over-crowded "skears" and laid down in suitable places.

In the following year 1905, the sum of £250 was voted for these transplantation operations, the bulk of the grant going, as heretofore, to Morecambe.

The work was carried out during neap tides, and on some days as many as 64 men with 32 boats were employed. Some 347 tons

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"Mussel Transplantation at Morecambe." *See* Report for 1905 on the Lancashire Sea Fisheries Laboratory at the University of Liverpool, and the Sea-fish Hatchery at Piel, drawn by Professor W. A. Herdman, D.Sc., F.R.S., Hon. Director of Scientific Work, assisted by Mr. Andrew Scott, A.L.S., and Mr. James Johnstone, B.Sc., Liverpool, 1906.

of mussels, varying in length from $1\frac{5}{8}$ to $1\frac{7}{8}$ of an inch, were deposited in what is known as the "Ringhole," from which place the mussels laid down in previous years had been removed. By way of assisting the efforts of the Committee, the Morecambe Fishermen's Association passed a resolution that no fishing of the transplanted mussels should take place before November 13th, an undertaking which was loyally observed, even although the mussels in the Ringhole were practically all common property.

It may be mentioned that in some places transplantation work has proved a failure owing to the rapacity of the fishermen and their hostility towards all scientific work. But in the Lancashire and Western District the admirable educational work carried out at the Marine Laboratory at Piel, has largely overcome this tendency on the part of the fisherfolk, who from being opponents to all innovations are gradually becoming ardent advocates of experimental work.

The actual procedure of mussel transplantation cannot be better described than in the words of Messrs. Scott and Baxter:—

"On the day appointed the fleet of boats, each manned by two or three fishermen, set off from Morecambe so that the 'skears' are reached some time before low water. The boats are anchored or run ashore and the men at once begin work. Each man has a basket and a craam, a sort of toothed rake, with which instrument he rapidly rakes the mussels into the basket. When it is filled the whole contents are washed in the sea water and then transferred to the boat. The operation is repeated until the boat has as much as it can carry in safety—from 10 to 15 bags representing a weight of from three-quarters of a ton to one ton of mussels. As soon as the boats are loaded they sail for the selected area. Each one anchors as it arrives, and all are inside a portion which has been previously marked by buoys. Two men station themselves beside the mussels, each armed with a shovel, while a third man attends to the anchor rope. Captain Wright, the Chief Officer of the Northern Division, usually supervises the arrangements. As soon as he sees that every boat is ready and not too close to its neighbours, a signal is given to unload.

"As the men discharge the mussels the man attending to the anchor pays out the rope and allows the boat to drift slowly with the tide. The boat is kept moving so that the mussels should not be deposited in a heap on each side. On every successive day a new portion of the selected area is buoyed and there is thus no over-crowding.

"The results of this mussel transplantation have been eminently satisfactory, the shells have grown rapidly and the size and character of the soft parts greatly improved. This has been so in a marked degree with what are known as 'blue nebs,' which are 'mussels which have ceased to grow and which are only existing.' They are found high up on the foreshore where they are only covered with water, and thus only supplied with food for a short period during each tide. Commonly, they are of no money value either as food or bait. But after having been transplanted for about five months these 'old starved, undersized 'blue nebs' had grown three-eighths of an inch and reached legal size,' and the total money value of the mussels which had been transplanted for £50 in 1905 was estimated to have been £500, and the results over the whole period of transplantation are thus summarised :—

"Amount expended—1903, £50; 1904, £50; 1905, £75.
"Estimated profit—1903, £500; 1904, £500; 1905, £800."

The Transplantation of Cockles.

Cockle transplantation has been carried out upon a much more limited scale than has been the case with mussels, and the only instances which have come to my notice have been those referred to in the Annual Report for 1905 on the Lancashire Sea-Fisheries Laboratory.

From this report, it appears that in June, 1904, some Southport fishermen undertook an experiment in the transplantation of cockles from a locality where they were abundant to one where there were none, and success is stated to have attended the venture.

In 1905 the sum of £20 was voted by the Lancashire and Western Sea Fisheries Committee for cockle transplantation or, otherwise stated, for the re-stocking of cockle beds at Southport and Lytham, which grant resulted in the transplantation of about 300 bags at Lytham and 260 at Southport.

The foregoing illustrations have been furnished in order to show that, with the co-operation of the fishermen, transplantation of the shellfish here under consideration is not only practicable but, in so far at least as mussels are concerned, eminently successful.

But the transplantation here referred to has been undertaken solely with the view of improving the value of the mussels as such; it has had no relation to the very important consideration of providing pure shellfish for human consumption; indeed, it is unfortunately the case that in certain instances the transplantation in question has resulted in the transference of mussels from relatively unpolluted sources to localities where they have been subject to the risks of contamination in a much greater degree. It is clear, however, that if some of the shellfish centres, dealt with in detailed fashion later on in this report, are to continue to supply the market, arrangements must at once be made either for the entire diversion of the sewers and drains which at present threaten their purity, or for the mussels to be transferred from the localities in which they have been placed by nature to others where they will be able to rid themselves of impurities which they may have taken up.

In fact, one of the most important results of the comprehensive investigation to which this report relates, has been to bring out prominently the fact that in this relaying or transplantation of mussels there is the only hope in certain cases of enabling the mussel industry to continue, and I have informally intimated the conclusion at which I have arrived to several of the more responsible officials connected with the scientific and administrative aspects of the shellfish industry.

Already some valuable experimental work in this connection has been undertaken under the auspices of the Lancashire and Western Sea Fisheries District Committee at Conway by Mr. James Johnstone, and the results of this work are recorded in Professor Herdman's Report on the Lancashire Sea Fisheries Scientific Investigation for 1908.

The pioneer work carried out by Dr. Klein for the Fishmongers' Company a few years ago, tended to show that oysters and mussels free themselves from sewage organisms when placed for several days in clean sea water, and work much on the same lines has been done by Herdman, Boyce, Chantemesse, and others.

Mr. Johnstone, profiting by previous work, selected what appeared to him to be from a topographical standpoint the purest part of the Conway estuary, and his selection in this sense being supported by the results of bacteriological investigation, he inferred that if mussels were transplanted from the polluted portion of the estuary to this locality, they would cleanse themselves from undesirable organisms.

Mr. Johnstone found that by this process of relaying there was brought about a decided reduction in the number of bacteria belonging to this *Bacillus coli* group.

In some cases there was a total disappearance of these organisms in the relaid mussel after 4, 8, and 16 days, and Mr. Johnstone regards the fact that a small proportion of the mussels transplanted did not cleanse themselves to an appreciable extent as due to the defects of the experiment which had, he states, to be carried out rather roughly. Had it been possible to have laid the mussels in large tanks instead of on the beach, the results would, he thinks, have been better. It was found that 4 days was a sufficient period of quarantine, since after that time no further cleansing took place.

The use of Mussels as Bait by the Long-line Fishermen, and the necessity for Regulations whereby differentiation may be made between Mussels intended to be used for Bait and those intended for Human Food.

As will be observed by the detailed account of the several mussel beds which is given later on in this volume, a very considerable percentage of mussels is still used as fish bait (*see* account of Northumberland fisheries), and it is important that some arrangement should be arrived at whereby the supply of these molluscs for bait may not be interfered with. The question is no doubt a very difficult one, since when, as at Yarmouth, the dredging of

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[*] Bacteriological Investigations in relation to Shellfish Pollution, by James Johnstone, B.Sc.

[†] Experiments and Observations on the vitality of the bacillus of typhoid fever and of sewage microbes in oysters and other shellfish. Investigations on behalf of the Worshipful Company of Fishmongers. London : By E. Klein, M.D., F.R.S. 1905.

mussels for bait is allowed, it is believed by the medical officer of health that some of such "bait" is occasionally sold for human food.

It will be seen that in the case of the Northumberland fisheries the estuaries of that county do not in most years yield a sufficient quantity of mussels for the needs of the fisherfolk, and, consequently, large quantities are imported from Morecambe Bay.

As regards the importance of mussels as bait, much useful information will be found in the evidence given before the Committee of Fishery Investigation, which was published in 1908.*

Mr. George Wilkinson, Clerk to the Northumberland Sea Fisheries Committee, stated that it has been a constant cause of complaint by the inshore fishermen that they had to go away from the district to procure bait.

Mr. St. Quintin, Chairman of the North-Eastern Sea Fisheries Committee, referred to the experimental work which had been undertaken by his Committee with regard to mussel culture for bait in the mouth of the Tees, which work had to be relinquished owing to the want of co-operation on the part of the fishermen, who objected to the payment of a royalty on the mussels collected. It seems, too, that in this district the fishermen are using escallops and other bait in substitution for mussels. Mr. St. Quintin added that the Tees mussels were consumed very largely as food in Middlesbrough and Stockton, but that their use as bait was much more important.

Mr. Herbert Donnison, Chief Fishery Officer of the Eastern Sea Fisheries District, in referring to the important mussel beds in the Wash, said that the men were doing capitally, and earning £3 or £4 a week. The mussels were, he added, used both for human food and bait, although the line fishermen did not use as many mussels for bait as formerly.

CHAPTER XII.

Administrative Considerations relative to the question of controlling the preparation, storage, and sale of shellfish with a view to limitation of the dangerous and undesirable condition of affairs which at present obtains.

It has already been made abundantly clear that there is little or no legal control exercised in what may be called a sanitary sense over the collection, storage, or washing of the shellfish with which this report is concerned, and, as has been shown, these shellfish are not infrequently collected from or laid down in very unwholesome localities as well as sometimes washed in positions and under circumstances which actually court specific contamination.

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* Reports and Minutes of Evidence given before the Committee appointed to enquire into the scientific and statistical investigations now being carried on in relation to the fishing industry of the United Kingdom. Wyman & Sons, Limited, [Cd. 4268], Price 2½*d*., and [Cd. 4304], Price 4*s*. 6*d*.

It is true, as has been said in Chapter III., that in certain of the Sea Fisheries Districts there are definite byelaws or regulations relating to the places at which and the methods by which shellfish may be collected, and in some instances certain areas may be closed or opened for fixed periods. But there is in none of these byelaws or regulations any power to prevent the collection, laying down, storage, or washing of shellfish in dangerous vicinity to sewer or drain outfalls.

As it is important to appreciate the difficulties which have hitherto prevented comprehensive action being taken, it may be well to recapitulate the conditions which now obtain, and reference may first be made to certain legal provisions which have a bearing upon the questions under consideration.

The two principal Public Health statutes dealing with the pollution of river or estuarial waters are—

The Public Health Act, 1875.
The Rivers Pollution (Prevention) Act, 1876.

As regards the first of these, Section 17 enacts that—

> "Nothing in this Act shall authorise any Local Authority to make or use any sewer, drain or outfall for the purpose of conveying sewage or filthy water into any natural stream or watercourse, or into any canal, pond or lake, until such sewage or filthy water is freed from all excrementitious or other foul or noxious matter such as would affect or deteriorate the purity and quality of the water in such stream or watercourse, or in such canal, pond or lake."

The second statute, the Rivers Pollution Prevention Act, 1876, does not apply to tidal waters unless and until the Local Government Board make an order extending the operation of the Act to such portions as they may after local inquiry and "on sanitary grounds" deem necessary.

In the opinion of certain sanitary authorities there is afforded in this statute the opportunity of remedying in a material degree existing conditions.

But with reference to this possible solution of the polluted shellfish difficulty it has to be borne in mind, as has already been pointed out, that there is at present no known method of sewage purification which will effectually remove the organisms from such sewage and, this being the case, it is clear that a shellfish estuary might be declared a "stream" and all the sanitary authorities draining therein put to great expense to purify their sewage, and yet the bacteriologist be able still to condemn both the shellfish and the water in the stream, or the epidemiologist be afforded ground for attributing enteric fever to shellfish gathered therein.

It is desirable that this undoubted difficulty should be realised by all those concerned with the administrative problems here arising. As to this, the Royal Commission on Sewage Disposal in their fifth report, after referring to the opinion of the Sewage Commission of 1868 to the effect that "rivers which had received "sewage, even if that sewage had been purified before its dis-"charge, were not safe sources of potable water," add, that in their view much the same position must be taken up to-day. They say:—

> "Although the methods available for the purification of sewage are more numerous than when the 1868 Commission reported, our examination of a very large number of effluents from sewage farms and from artificial filters of various kinds shows that, although such effluents may be very good as judged by chemical and physical tests, they are generally liable to contain large numbers of micro-organisms of intestinal derivation, and that if such organisms are to be destroyed or eliminated the effluents must be subjected to some treatment additional to that which is ordinarily employed."
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> Some experiments, they add, "which have been carried out by Dr. Houston show that while it would be practicable to render sewage effluents fairly pure bacteriologically, the cost of the necessary additional treatment would be serious. Moreover, a false sense of security would be obtained by the adoption of such further treatment unless at the same time storm overflows on sewers were abolished. In the great majority of towns sewers are provided with storm overflows, by which, in times of storm, large quantities of sewage are discharged into the river or stream untreated. Such discharges we find are frequently more impure bacteriologically than the crude sewage."

With respect to the reconstruction of sewers so as to allow of the abolition of storm overflows, the Commissioners are of opinion that the cost, when considered in conjunction with the necessary purification plant, would be practically prohibitive, and even if the expenditure were met, the water of rivers would generally still require to be treated before it could be safely distributed for drinking purposes.

A somewhat similar comment has to be made with reference to the provisions of Section 2 of the Sea Fisheries Regulations Act, 1888, which authorises Sea Fisheries Committees to make byelaws "for prohibiting or regulating the deposit or discharge of any solid or liquid substances detrimental to sea-fish or sea-fishing," and by the definition in the Acts "sea-fish" includes "shellfish."

This might at first sight appear to give the Fisheries Committee a powerful weapon for the prevention of additional pollution by sewage, but Section 13 of this same Act provides that "nothing in this Act shall authorise a local fisheries committee to make any byelaw . . . . (*c*) affecting any power of a sanitary or other local authority to discharge sewage in pursuance of any power given by a general or local Act of Parliament or by a Provisional Order confirmed by Parliament," and although several of the Sea Fisheries Committees have, with the consent of the Board of Trade, made byelaws prohibiting or regulating the deposit or discharge of any solid or liquid substance detrimental to sea-fish or sea-fishing, the Board of Trade have taken the view that the proviso of Section 13 above referred to renders the byelaws inapplicable to the discharge of sewage of local authorities, since it is held by that Board that the authorities are acting under the Public Health Act.*

There are also certain other statutes to which reference may be made. Section 5 of the Salmon Fishery Act, 1861, provides that—

> Every person who causes or knowingly permits to flow, or puts, or knowingly permits to be put, into any water containing salmon, or into any tributaries thereof, any liquid or solid matter to such an extent as to cause the waters to poison or kill fish, shall incur the following penalties (that is to say):—
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> (1) Upon the first conviction a penalty not exceeding five pounds.
>
> (2) Upon a second conviction a penalty not exceeding ten pounds, and a further penalty not exceeding two pounds for every day during which such offence is continued.
>
> (3) Upon a third or any subsequent conviction a penalty not exceeding twenty pounds a day for every day during which such offence is continued, commencing from the date of the third conviction.
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> But no person shall be subject to the foregoing penalties for any act done in exercise of any right to which he is by law entitled if he proves to the satisfaction of the Court before whom he is tried that he has used the best practical means within a reasonable cost to render harmless the liquid or solid matter so permitted to flow or to be put into waters; but nothing herein contained shall prevent any person from acquiring a legal right in cases where he would have acquired it if this Act had not been passed, or exempt any person from any punishment to which he would otherwise be subject, or legalise any act or default that would, but for this Act, be deemed to be a nuisance or otherwise contrary to law.

The Salmon Fisheries (Scotland) Act, 1862, contains in Section 13 a similar provision, but as to both these sections the Royal Commission on Salmon Fisheries in their report of the 10th of July, 1902, make the following observations:—

> "Under the existing Salmon Fishery Acts it is necessary to prove that the pollution complained of has poisoned or killed fish in England, or has poisoned or been deleterious to salmon to an extent injurious to any salmon fishery in Scotland, or has poisoned or killed any salmon or smolt in the Tweed, but it is by no means easy to establish a sufficient case; and, further, under the English and Scotch General Acts, no person is liable if he prove to the satisfaction of the Court that he has used the best practicable means within a reasonable cost to render the pollution harmless. We are of opinion that Section 13, Salmon Fisheries (Scotland) Act, 1862, should be amended by striking out the words, 'to an extent injurious to any salmon fishery,' and think it desirable that Section 5, Salmon Fishery (England) Act, 1861, should be made to conform with the Scottish section so amended."

The net result is that the law as at present interpreted does not prohibit the discharge of sewage into tidal waters.

But although this is the case under the Public Health statutes several local authorities have had reason under the common law to regret such discharge in the vicinity of shellfish beds, and the Local Authorities of Southend, Emsworth, and Faversham, against all of whom injunctions have been obtained prohibiting them from discharging sewage in the vicinity of the neighbouring shellfish beds, are instances in point.

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* The duties here referred to are now carried out by the Board of Agriculture and Fisheries.

In the spring of 1896 the Brighton Corporation endeavoured to obtain power by means of a clause in a private Bill to prevent the importation of sewage-contaminated shellfish into the borough.

This clause was considered by the Police and Sanitary Committee of the House of Commons, but after a protracted hearing was struck out by them.

The powers sought to be obtained were practically those provided for in the case of milk by the Infectious Diseases (Prevention) Act, 1890, and as the Brighton proposal has a general interest and importance the terms of the clause are here reproduced.

> In case the medical officer of health is in possession of evidence that any person in the Borough is suffering from infectious disease attributable to the consumption of shellfish supplied within the Borough from any pond, river or other place situate within or without the Borough in which shellfish are commonly kept, bred, or cultivated, and in which pond, river or place such shellfish have been (or are liable to be) exposed to contamination by sewage, or that the consumption of shellfish from such pond, river or place is likely to cause infectious disease to any person residing in the Borough, such medical officer of health shall, if authorised in that behalf, by an order of a Justice having jurisdiction in the locality in which such pond, river or place is situate, have power to inspect such pond, river or place and all shellfish matters and things therein, and if on such inspection the medical officer of health is of opinion that infectious disease is, or is likely to be, caused by the consumption of shellfish supplied from such pond, river or place, he shall report thereon to the Corporation or to the Sanitary Committee of the Council, and the Corporation or the Sanitary Committee, as the case may be, may thereupon give notice to the person by whom such shellfish is so kept, bred, or cultivated, to appear before them within such time, not being less than twenty-four hours, as shall be specified in the notice, to show cause why an Order should not be made prohibiting the supply within the Borough of any shellfish from such pond, river or place, until such Order has been withdrawn by the Corporation or the Sanitary Committee, as the case may be, and if in the opinion of the Corporation or the Sanitary Committee, as the case may be, such person fails to show such cause, then the Corporation or such Committee, as the case may be, may make such Order as aforesaid, and the Corporation or such Committee, as the case may be, shall forthwith give notice of this fact to the Sanitary Authority and County Council (if any) of the district or county in which such pond, river or place is situate, and also to the Local Government Board. An Order made by the Corporation or such Committee as aforesaid in pursuance of this Section shall be forthwith withdrawn on the Corporation or such Committee, as the case may be, or the medical officer of health being satisfied that the cause of the infection has been removed.
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> Any person refusing to permit the medical officer of health, on the production of such Order as aforesaid, to inspect any such pond, river or place, or after any such Order prohibiting the supply of shellfish as aforesaid has been given, supplying within the Borough any shellfish from such pond, river or place in contravention of such Order, or selling it for consumption in the Borough, shall be liable to a penalty not exceeding five pounds, and to a daily penalty not exceeding forty shillings.

Provided always that proceedings in respect of such offence shall be taken before the Justices of the Peace having jurisdiction in the locality where the said pond, river or place is situate. Provided that no person on whom an Order prohibiting the supply of such shellfish has been made by the Corporation or such Committee as aforesaid shall be liable to an action for breach of contract if the breach be due to such Order. Every person who shall wilfully obstruct such medical officer or other officer of the Corporation assisting him in the exercise of the powers of this Section shall be liable for such offence to a penalty not exceeding five pounds.

Powers Conferred by the Blackburn Corporation Act, 1908.

In view of the unsuccessful attempt made by the Brighton Corporation in the year 1896, it is instructive to note that twelve years later—in the year 1908—the Blackburn Corporation obtained the consent of Parliament to provisions very similar to those proposed by Brighton.

Section 70 of the Blackburn Corporation Act, 1908, which comprises the powers in question, will be found in full in Appendix No. 2 (p. 242), but it may here be stated that under its provisions the Corporation may prohibit the sale in Blackburn of shellfish coming from beds against which an Order has been issued. Appeals against such an Order, or against refusal on the part of the Corporation to withdraw such an Order, or cause for such withdrawal being shown, may be made by the person involved either to a Petty Sessional Court having jurisdiction within the borough, or, at his discretion, to the Local Government Board, who must then appoint an officer to hear the appeal.

The Oysters Bill, 1899.

In 1899 an attempt was made to deal with the question of shellfish pollution by means of the Oyster Bill which was introduced by Mr. Chaplin, at that time President of the Local Government Board. It was proposed by this Bill* that the local authorities should be the councils of every county and every county borough, while the Central Authority should be the Local Government Board.

The object of this measure (the text of which is furnished on (page 239) was to bestow upon county councils and county boroughs power to prohibit the despatch of oysters to market from certain layings, and to enact that where beds or layings were contaminated, oysters taken therefrom should be deposited for ten days upon approved layings before they were despatched to market for consumption.

It was made the duty of the council of every county and borough to ascertain from time to time the sanitary condition of oyster layings, and power was conferred upon such councils to enter layings for the purpose of taking samples. Appeal to the

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* A Bill intituled an Act for the Protection of Public Health against dangers arising from the Consumption of Unwholesome Oysters, 1899.

Local Government Board was given against the decision of the councils, and powers were bestowed upon the Local Government Board to act in default of such councils.

In Scotland the above powers and duties were imposed upon the local authorities under the Public Health (Scotland) Act, 1897, and in Ireland urban districts were substituted for boroughs.

With regard to foreign oysters, the Bill proposed that on a certificate of the British Consul it should be possible to prohibit the introduction of oysters.

> 6.—(1.) If it is made to appear to Her Majesty in Council that any oyster laying situate in any foreign country or British possession is so situate with reference to an outfall of sewage that there is serious risk of disease being communicated by the consumption of oysters taken from that oyster laying, it shall be lawful for Her Majesty in Council by order to prohibit the importation into the United Kingdom of oysters brought from that oyster laying or from any specified part of that country or possession which includes that laying, except on such terms with respect to the temporary deposit of the oysters or otherwise as may appear to Her Majesty in Council expedient for the purpose of removing the risk of communicating disease.
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> (2.) Oysters imported in contravention of any order made under this Section shall be included amongst the goods enumerated as described in the schedule of prohibitions and restrictions contained in Section Forty-one of the Customs Consolidation Act, 1876 [39 and 40 Vict. c. 36].

This Bill had no application to natural oyster beds, and it was not regarded as properly applicable to the case of Ireland and Scotland. It did not, moreover, provide for the registration of oyster layings or grounds, and it did not deal with shellfish other than oysters. It would, however, if it had become law, have provided a machinery which could easily have been extended to other shellfish which might have prevented material disease and loss of life and have saved the shellfish industry from further damage.

But the representatives of the fishing industry, when giving evidence before the House of Lords Committee* which was appointed to consider the measure, strongly opposed the proposal to vest the administration of the measure in the County and Borough Councils, and the Lords Committee finally substituted the Sea Fisheries District Committees as the Local Authorities. The Local Government Board therefore decided to withdraw the Bill.

Attention may now be directed to the consideration of the claims of one or another Local Authority to act as the administrative channel for the carrying out of such enactments as may be made by Parliament for the prevention of the spread of disease and illness through the consumption of polluted shellfish.

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* Report from the Select Committee of the House of Lords on the Oysters Bill [H.L.], together with the Proceedings of the Committee on Minutes of Evidence. Session, 1899 (172). Eyre & Spottiswoode, London, Price 5½*d*.

Local Sanitary Authorities.

In so far as Local Authorities having shellfish beds within their districts are concerned, it will be seen from the detailed account of the shellfish areas which follows that some of the most important centres are situated in estuaries where, unless joint boards or joint jurisdiction were provided for, divided authority would result by virtue of the fact that the estuaries abut upon the district of more than one Local Authority, or the rivers which empty into the estuaries traverse numerous sanitary districts.

If therefore, each sanitary authority was given power to control so much of the shellfish as was embraced within the area which abutted upon its district, there might, it is to be feared, be much reduplication and overlapping of functions, or perhaps more probably general inactivity.

But another reason has been urged against the promiscuous conferment of power upon Local Authorities in whose districts there are important shellfish beds, and this is the fact that the prominence of the local shellfish industry might render the position of the Local Authority very difficult in an administrative sense, and it has, moreover, to be borne in mind that in quite small districts the danger which threatens the local population is much smaller than that which threatens the public of the larger towns to which the shellfish are sent. It would be both invidious and unnecessary to furnish specific illustrations of this point; it will suffice to say there are several instances around the English and Welsh littoral.

County Councils.

The Oyster Bill of 1899 proposed to confer the powers then considered necessary upon the councils of counties and boroughs, and although there are numerous arguments in support of this action, attention has been drawn to certain drawbacks to which reference may be made. In so far as the more important shellfish centres are concerned, the counties which would be more or less actively involved with the registration of layings and the delineation of approved and prohibited areas, would be from east to west, Northumberland, Durham, Yorkshire, Lincolnshire, Norfolk, Suffolk, Essex, Kent, Sussex, Hampshire, Dorset, Devon, Cornwall, Glamorgan, Carmarthen, Pembroke, Cardigan, Merioneth, Carnarvon, Anglesey, Denbigh, Flint, Cheshire, Lancashire, and Cumberland.

Certain of these county councils do not at present possess a full-time medical officer of health. But under the provisions of Section 68 of Part III. of the Housing and Town Planning Act, 1909, it is the duty of every county to appoint a medical officer of health under Section 17 of the Local Government Act, 1888, whose duties as a county medical officer of health are prescribed by General Order of the Local Government Board.

It is, however, to be assumed that unless joint committees were formed, none of these counties would have jurisdiction outside their own limits, and, consequently, they would have no power to deal with pollution entering these estuaries from outside their limits. There is, too, the further difficulty that in the case of estuaries which separate counties from one another there would be divided jurisdiction, that is to say, if each county had jurisdiction over the territorial water abutting upon its littoral, and if in the case of county-dividing estuaries, the jurisdiction of each county extended to mid-stream. An arrangement, therefore, by which separate county councils were the local administrative authorities would, to quote certain illustrations only, mean divided jurisdiction in the Tweed, the Tees, the Wash, the Thames, Burry Inlet, Barmouth Estuary, Conway River, the Dee, the Mersey, and the Duddon. Clearly, some of these objections would be removed by the formation of joint committees.

Port Sanitary Authorities.

Although in certain instances Port Sanitary Authorities might be usefully employed towards the better sanitary control of shellfish, it would not seem practicable to confer upon them generally the duties of such control. In many of our most commercially important estuaries there are but few, if any, shellfish, while in connection with many of the most important shellfish areas there are no Port Sanitary Authorities.

But although this is so there can be no question that the assistance of the Port Sanitary Authorities would in many cases be of the greatest value, seeing that the constant presence of their skilled officers on the rivers affords them opportunities for observation which would enable them to detect breaches of the byelaws in the collection of shellfish from prohibited areas. Moreover, in certain instances the divided jurisdiction which would ensue were County Councils the administrative units would be obviated, and, in so far as both foreign or native shellfish are concerned, the services of the Port medical officers of health must in the future prove indispensable in connection with regulations made under the Public Health (Regulations as to Food) Act, 1907.

The Committees of the Sea Fisheries Districts.

As has been already said, practically the whole of the English and Welsh littoral is in fishing matters under the control of Sea Fisheries Committees, and it was to these Committees that the House of Lords Committee, which considered the Oyster Bill of 1899, proposed to delegate the local administration of the provisions contained in the Bill in lieu of, as proposed by the Local Government Board, the councils of counties and boroughs. It is therefore necessary to consider in some detail the merits of this proposal.

These districts are 13 in number and are as follows:—

Cumberland (Sark Foot to Haverigg Point).

Lancashire and Western (Haverigg Point to Cemmaes Head).

Milford Haven (Cemmaes Head to Worms Head).

Glamorgan (Worms Head to Nash Point).

Cornwall (Northern boundary of Cornwall to Rame Head).

Devon—

Northern Section (Eastern boundary to Western boundary of Devon).

Southern Section (Rame Head to Eastern boundary of Devon).

Southern (Western boundary of Dorset to Hayling Island).

Sussex (Hayling Island to Dungeness).

Kent and Essex (Dungeness to Dovercourt).

Eastern (Southern boundary of Norfolk to Donna Nook Beacon).

North Eastern (Donna Nook Beacon to River Tyne).

Northumberland (the River Tyne to the boundary between England and Scotland).

The Fisheries Committees are comprised of—

Members appointed by the County Council.

Members appointed by the Borough Councils.

Fishery members appointed by the Boards of Conservators.

Fishery members appointed by the Board of Trade.

The bulk of the representatives in each instance are appointed by the County Councils and by the Board of Trade.

The total membership of the Committees ranges from 12 in the case of Glamorganshire to 64 in the case of Lancashire.

Each of these Committees employs a clerk and one or more Inspectors or Fishery Officers, but none of them possesses a medical officer of health or other officer with a public health certificate or diploma. Several of the Committees have at their disposal a steamer which enables their officers to move from one place to another with rapidity, such Committees being the North-Eastern, the Eastern, the Lancashire and Western, and the Cumberland. It is clear that from a purely inspectorial standpoint the services of these officers would be most valuable, and I feel sure from a fairly intimate knowledge of the character of their work that they would cordially co-operate with and assist whatever existing or newly-created body upon which executive powers are conferred.

Hitherto these committees, with one notable exception, have not concerned themselves with the public health aspect of the shellfish question. Their duties have consisted solely in regulating the collection of shellfish in a manner calculated to yield the best commercial results to the fishermen not only in the present but in the future, and in carrying out their duties towards this end they have, in the earlier days of their history, encountered considerable opposition from the fishermen, who were slow to recognise that it was their interests alone which were being fostered. But the Officers of the Lancashire and Western Sea Fisheries Committee have under the guidance of the Honorary Director, Professor Herdman, F.R.S., together with Dr. Jenkins, Mr. Johnstone, and Mr. Andrew Scott, made a detailed survey of the shellfish beds and areas in their district and of the sewers and drains which discharge in their vicinity. They have also from time to time made valuable bacteriological examinations of the waters and shellfish in different places and have conducted experiments as regards the relaying of shellfish, which are likely to prove of permanent value both to the shellfish industry itself and to the public health.

So far as I am aware none of the other Sea Fisheries Committees, as such, have taken serious steps to remedy the present unwholesome condition of affairs, but quite recently, since the commencement of the inspection to which this report relates, both the Eastern and North-Eastern Committees have taken certain measures.

Although, therefore, it might not be desirable or, indeed, practicable to place the administration of health measures in the hands of the Sea Fisheries Committees the co-operation of these bodies is in every way desirable, and it might be the duty of their officers to draw attention to any unwholesome practices in connection with shellfish which they observed in the course of their routine inspectorial duties.

It has further to be stated that the limits of jurisdiction of certain of these Committees are such that in some instances no control over shellfish areas, except by extension of jurisdiction, would be exercised by them. Unless their areas and powers were extended, control would have to be undertaken by the Boards of Conservators in different estuaries, none of whom have either experience in public health questions, or officers to advise them in these matters.

These difficulties were pointed out to the House of Lords Committee in 1899, but, this notwithstanding, they substituted the Sea Fisheries Committees for the County Councils, with the result that the Bill was withdrawn as being then of relatively little value from a public health point of view.

In this connection it may be of interest to draw attention to the observations contained in the Fourth Report of the Royal Commission on the Treatment and Disposal of Sewage. This report is devoted almost entirely to the shellfish question, and the Commissioners, who went very thoroughly into the subject, state, when considering the authorities who should carry out the administrative measures:—

"Neither do we consider that the Local Authority substituted by the House of Lords Committee could properly be accepted. Indeed, in some respects, this amendment is open to more serious objection than the original Bill.

"We fully realise that the Fisheries Committees have done excellent work, but they are in no sense sanitary bodies, yet the control which we are discussing is essentially a sanitary matter involving at times sanitary questions of great complexity and difficulty. Moreover, their organisation and constitution are not such as are required for the exercise of the control which is needed. Further their interests are in the main bound up with the industry, and the matters to be dealt with would frequently involve decisions on questions in which these interests and those of the public health would come into conflict. For these reasons we think it would be unwise to place the local control in their hands."

The Powers of the Fishmongers' Company and the Action taken by them in pursuance of such Powers.

The powers exercised by this company over the sale of shellfish in London were accorded them by Charter in the reign of James I. as well as by the Fisheries (Oysters, Crabs, and Lobsters) Act, 1877.

From a strictly legal standpoint the powers of the company are confined to the refusal of admission of fish into Billingsgate Market, and to the seizure and destruction of any unwholesome fish exposed therein for sale.

Any fish seized in the above sense is removed by the manure contractor to the company, carbolic acid being poured over it before despatch so as to prevent its subsequent sale or consumption.

But although the strictly legal powers of the company are confined to fish proposing to be sent to, or actually received into, Billingsgate Market, the influence exercised by the company in the fish trade is so material that they are able to prevent the introduction of fish to many other metropolitan centres than Billingsgate.

The powers thus possessed by this company have been utilised towards improving the beds or layings whence London shellfish is derived, and in this direction the influence of the company has been decidedly good.

As an illustration of the practical utility of their efforts, reference may be made to the fact that the company, by virtue of their powers, excluded the Leigh cockles, which were being prepared under eminently unwholesome conditions, from admission to London markets until, at a substantial cost to the cocklers, arrangements had been made whereby the cockles could be cooked by steam under pressure for such a period as would, on the basis of experiments conducted by Dr. Klein, F.R.S., guarantee their complete sterilisation. The company have also endeavoured to promote such transplantation or relaying of oysters and mussels as will enable the shellfish to cleanse themselves, and in several places around the coast there have been brought to my notice the praiseworthy efforts of the company in this direction.

There can, I think, be no question that the condition of the oyster beds and layings in many parts of both the English and Welsh littoral has been materially improved by the efforts of the company, and the work which is being done by them as regards mussels and cockles should lead to less risk being incurred from these molluscs.

There has recently been printed " For the information of the Fishmongers' Company " a full account of the investigations made by them from December, 1902, to June, 1909, such account embodying the results of the bacterioscopic examinations made on their behalf by Dr. Klein, F.R.S.

The Application of the Provisions of the Public Health (Regulations as to Foods) Act, 1907.

This measure, which came into operation at the beginning of 1908, contains some important provisions as regards home and foreign food supplies.

Section 1 of this Act extends the provisions of the Public Health Act, 1896, so as to include the power of making regulations authorising measures to be taken for the prevention of danger arising to the public health from the importation, preparation, storage, and distribution of articles of food or drink intended for sale for human consumption.

The Belfast Health Commission in their report, when dealing with the prevalence of enteric fever in Belfast and its relation to the consumption of shellfish from Belfast Lough, observe:—

> " It may also be matter for consideration whether the powers conferred by the Public Health (Regulations as to Food) Act, 1907, may be usefully applied to this question so far as it relates to ' the prevention of danger arising to the public health from the . . . distribution of shellfish intended for sale for human consumption.'
>
> " In view of the large export of shellfish from Belfast, the applicability of this Act for the purpose indicated appears to deserve consideration, not only by the Local Government Board of Ireland, but also by the corresponding central departments for England and Wales and for Scotland."

Report of the Royal Commission on Sewage Disposal.

The subject of the pollution of tidal waters, with special reference to the contamination of shellfish, was investigated with great care by the Royal Commission on Sewage Disposal, and the results of their investigations and deliberations are embodied in their fourth report which was issued in the year 1904.*

The Commissioners examined a large number of witnesses and visited many of the more important shellfish centres in the country. They also caused to be carried out by Dr. Houston very extensive bacteriological examinations of shellfish procured from different parts of the littoral.

The Commissioners, as the result of their investigations, arrived at the following conclusions:—

> After carefully considering the whole of the evidence, together with the results of our own investigations and local inquiries, we are strongly of opinion that the only way in which this evil can be effectively dealt with is by placing tidal waters under the jurisdiction of some competent authority and conferring upon that authority power to prevent the taking of shellfish for human consumption from any position in which they are liable to risk of dangerous contamination, and to enforce restrictions as regards pollution and as regards waters, foreshores, pits, ponds, beds, and layings in which shellfish are fattened or stored, as and when required.
>
> For this purpose the powers of the authority must be elastic. The case of each river and estuary is a problem by itself, and it would not be practicable to fix by enactment any standard or standards which would be generally suitable to the widely different conditions of different cases. Moreover, as the conditions are shifting in character it is necessary to provide some permanent machinery by which restrictions can be varied.

The Commissioners then proceed to deal with the question of—

River Boards.

43. "The witnesses representing Local Authorities are generally " in agreement in thinking that the necessary control could best " be exercised through the machinery of large River Boards and a " Central Authority which we recommended in our Third Report, " and there is reason to think that these bodies would generally " command the confidence of the trade.

" Mr. Wrench Towse, the Clerk to the Fishmongers' Company, " stated that 'the recommendation is as good as I have heard or " could suggest'" (19,669).

And the Commissioners then go on to quote the following interesting passage from the Report of the Salmon Fisheries Commission:—

Page 12.

> " We think that in any event there ought to be a Board capable of dealing with the fisheries of an entire watershed. The Royal Commission on Sewage Disposal has announced its adherence to this principle in the matter of the pollution of rivers, and it will be seen below that we concur in that opinion. If workable, Boards can be formed for so

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* Fourth Report of the Commissioners appointed in 1898 to enquire and report upon methods of Treating and Disposing of Sewage. Pollution of Tidal Waters with special reference to contamination of Shellfish. [Cd. 1883.]

delicate and complicated a work as the purification of rivers, and the experience of the West Riding and of Lancashire is entirely favourable, we see no reason why the administration of the fisheries should not be satisfactorily reformed in like manner, is not entirely on the same lines."

* * * * * *

"There are three great subjects, for all of which, in our opinion, the watershed is the proper administrative area, *i.e.*, Pollution, Water Supplies and Fisheries. If it were possible to give adequate representation to all the interests concerned in one body, we should have a Board of great influence capable of interfering authoritatively in any matter affecting the district, while by the formation of separate Committees, the administration of each of the subjects above named might be left in the hands of representatives best qualified to carry it on."

PAGE 46.

"The Commissioners (Sewage) in their interim report, dated July 12th, 1901, have dealt with the question of 'what means should be adopted for securing the better protection of our rivers,' and have recommended a single authority for each watershed under a Supreme Rivers Authority. This recommendation we unhesitatingly adopt and cordially support, and on page 12 we have suggested that the same authority might administer fishery matters in England and Wales."

Conclusions.

The investigation to which the foregoing report relates has brought out prominently the following considerations:—

(*a.*) That both enteric fever and gastro-enteritis are not infrequently caused by the consumption of mussels or cockles eaten raw or imperfectly cooked.

(*b.*) That the shellfish here in question are in many instances collected from natural "scalps," beds, or layings, which are liable to become specifically polluted by sewage.

(*c.*) That even when these shellfish are procured from localities remote from the risks of pollution they are, at times, washed, stored, or laid down in dangerous proximity to sewer or drain outfalls.

(*d.*) That the shellfish with which this report is concerned may occasionally become polluted either specifically or otherwise by the treatment to which they are subjected by the sellers.

(*e.*) That at the present time there is practically no control, in a sanitary sense, exercised over places from which these shellfish are collected, or wherein they are laid down, washed, or stored.

(*f.*) That large quantities of the shellfish here under consideration are introduced into England and Wales from Scotland and Ireland and that, therefore, any regulations or restrictions to be effectual should apply to all parts of Great Britain and to Ireland.

(*g.*) That as large quantities of shellfish are introduced into this country from abroad, notably from Holland, France, and America, any legislation directed to the control of the home industry must also take account of foreign importations.

(*h.*) That so long as the state of affairs revealed in this report obtains both with regard to home and foreign shellfish those persons who desire to avoid contraction of shellfish-borne enteric fever or gastro-enteritis should either abstain entirely from such shellfish as mussels or cockles or consume them only after they have been actually at the boiling point for at least five minutes.

The remedy for the condition of affairs revealed in this report is obvious, and it consists in devising means whereby shellfish for human consumption, whether oysters, mussels, or cockles, shall no longer be laid down, stored or washed in, or gathered from positions liable to contamination. Adequate precautions also necessitate provision for the periodical inspection of and reports upon places from which shellfish are procured or in which they are cleansed and prepared for market.

It would clearly be desirable, while regulating the shellfish beds and layings of England and Wales, at the same time to control the shellfish supplies of Ireland, Scotland, Holland, France, and America, some of which at least are known to be subject to contamination in no less degree than those of England and Wales.

PART II.

CHAPTER XIII.

The following account of the Mussel and Cockle Beds in England and Wales commences at Berwick-upon-Tweed, on the east, and traverses the East, South, and West Coasts until it terminates in Solway Firth on the Scotch Border.

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RIVER TWEED MUSSEL BEDS. (Map No. 3.)

The estuary of the Tweed, immediately below Berwick, is a broad relatively shallow stream forming at high water an expanse nearly half-a-mile broad, and at low water a shallow channel of much narrower limits.

It is in the bed of the low-tide channel and at places over the area coloured blue on map No. 3, that mussels are found.

The mussels are, for the most part, dredged up by means of dredges, similar in type to those used for oyster dredging, or by means of rakes, and when collected they are deposited on the southern foreshore above low-tide limits, each separate holding being covered with a net in order to mark it off from other holdings or heaps. When required for bait, the mussels are collected from the foreshore at low tide.

So far as I was able to ascertain, by the help of Fishery Officer Buglass and Mr. Dickinson, the Berwick surveyor, no mussels are sold for other than bait purposes, none being used for food. There are about 50 fishermen who dredge for mussels in the Tweed, and, sometimes, especially at low water of spring tides, women are engaged in hand-picking the shellfish.

At the time of the survey made by Miss Marie V. Lebour, B.Sc.,* of Armstrong College, Newcastle, there were no mussels on the southern side of the channel, but the year 1908 was a remarkably favourable one, and the molluscs were found over a much wider area than had been the case for many previous years.

Up to 1908 it had been necessary every season to import large quantities of bait from Morecambe, but during 1908 no such importation was, apparently, called for.

Miss Lebour suggested that by a well-regulated system of transplantation, enough mussels could be obtained at Berwick without importation; and the records of the year 1908 would seem to hold out promise that much more might be made of the potentialities of this estuary than has hitherto been the case.

The Pollution of the Tweed in the neighbourhood of Berwick.

The total population of Berwick at the Census of 1901 was 13,437; the urban district comprising practically three more or less distinct drainage areas:—Berwick-upon-Tweed, to the north of the estuary, and Tweedmouth and Spittal on the south.

From Berwick proper there are eight separate outfalls from its population of about 8,000; from Tweedmouth, one large sewer and numerous rivulets bearing down some drainage, and from Spittal two outlets. Berwick and Spittal are, largely, water-closet districts, while Tweedmouth is served, mainly, by privies.

The three main Berwick outfalls are those situated immediately south of Berwick bridge, these being not far distant from the beginning of the mussel area, while the chief Tweedmouth outfall, which drains a population of about 2,000, discharges on the opposite side, and rather nearer to the mussel area. At Spittal, the two main outfalls discharge into that portion of the channel over parts of which mussels are collected.

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* Report of Northumberland Sea Fisheries Committee. Report on the Scientific Investigations for the year 1906, edited by Alexander Meek, M.Sc., F.Z.S.

On the opposite side of the river, and running over what is known as the Calot Shad, are two sewers. The more inland of them takes the sewage exclusively from the barracks, which may, I am informed, contain a population of about 300, when full. The other sewer, which drains the coastguard premises, serves a population of about 50.

Having regard to the fact that no mussels from this area are used for human food, it is not necessary to discuss the question of pollution in detail, but it is clear from the fact that, at times, the mussels have not more than three feet of water over them, that the risk of specific contamination is present. As regards the two Calot Shad outfalls, it may be observed that the configuration of the foreshore hereabouts is such that the sewage discharged must, under certain conditions, reach the mussel beds.

HOLY ISLAND MUSSEL BEDS. (Map No. 4.)

Between the mainland and Holy Island there dries at low tide an extensive expanse of sand, part of which, the northern, is known as "Holy Island Sands," the remainder, the southern portion, as "Fenham Flats." Between these two there runs what may be termed the main channel, which drains the whole area of the sands as well as some of the neighbouring country, and empties itself into the sea viâ Holy Island Harbour, which lies immediately to the south of the island.

It is over the Fenham Flats, in the positions indicated in blue, that mussels are collected for bait by the fishermen of Holy Island. The mussels are gathered by hand, and those which are not immediately required are deposited on what is known as the "oyster scalp," near Guile Point. This "scalp" only dries at low water of spring tides.

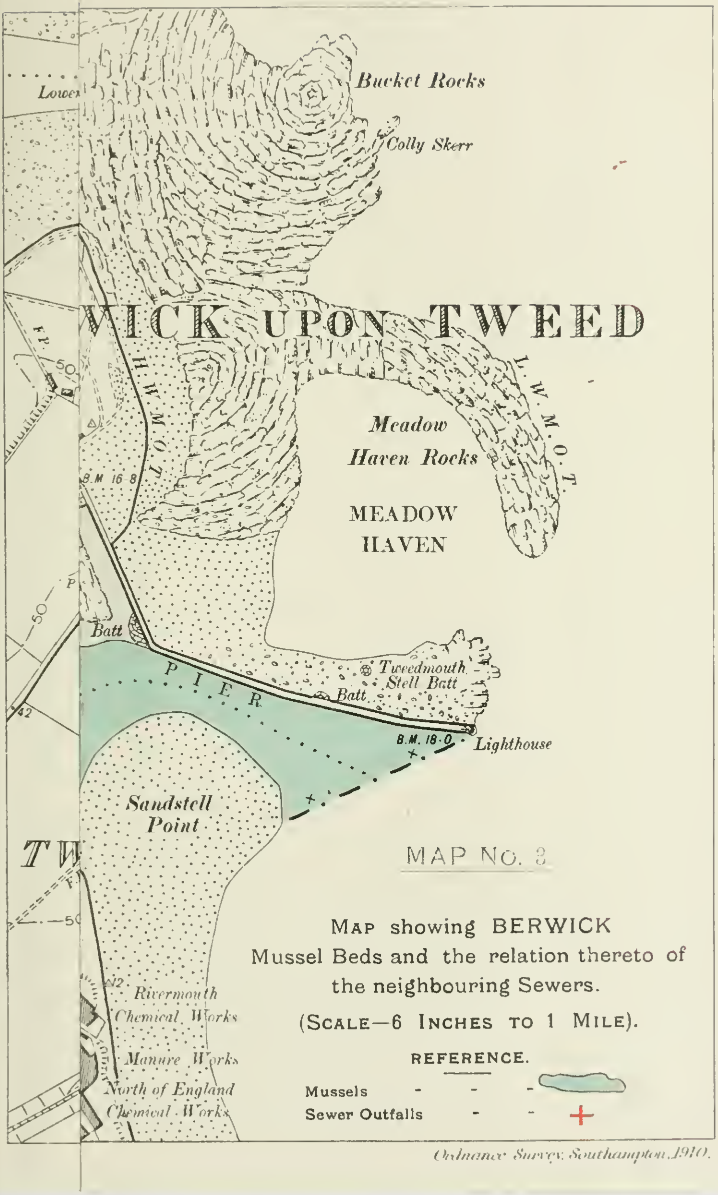
The mussels, over the more southern portion of Fenham Flats, are small in size, owing to the long period during which they are uncovered, but in and near the channels which traverse the Flats, and where mud gives place to gravel, the molluscs attain to considerable size.

The mussels on these "scalps" are reported by Miss Lebour to have undergone some diminution of late, a circumstance which she attributes to the ravages of the dog whelk (*Purpura lapillus*), the spawn of which is freely distributed over this mussel area.

The mussels hereabouts belong to the lord of the manor, to whom a nominal fee is, I understand, paid by the fishermen for the right to collect the shellfish.

There are some 40 Holy Island fishermen who make use of these mussels for bait, and consequently the bait industry in this locality must be regarded as one of no small importance. Mr. Buglass, the Fishery Officer, tells me that the Holy Island fishermen alone use annually some 40 tons of mussels for bait, the value thereof being about £100.

Professor Meek informs me that experimental mussel culture has now been commenced at Holy Island and that mussels which have been moved from shallow to deeper water have in a short time cleansed themselves of the B. coli which they contained in the shallow positions.



MAP No. 3

Map showing BERWICK Mussel Beds and the relation thereto of the neighbouring Sewers.

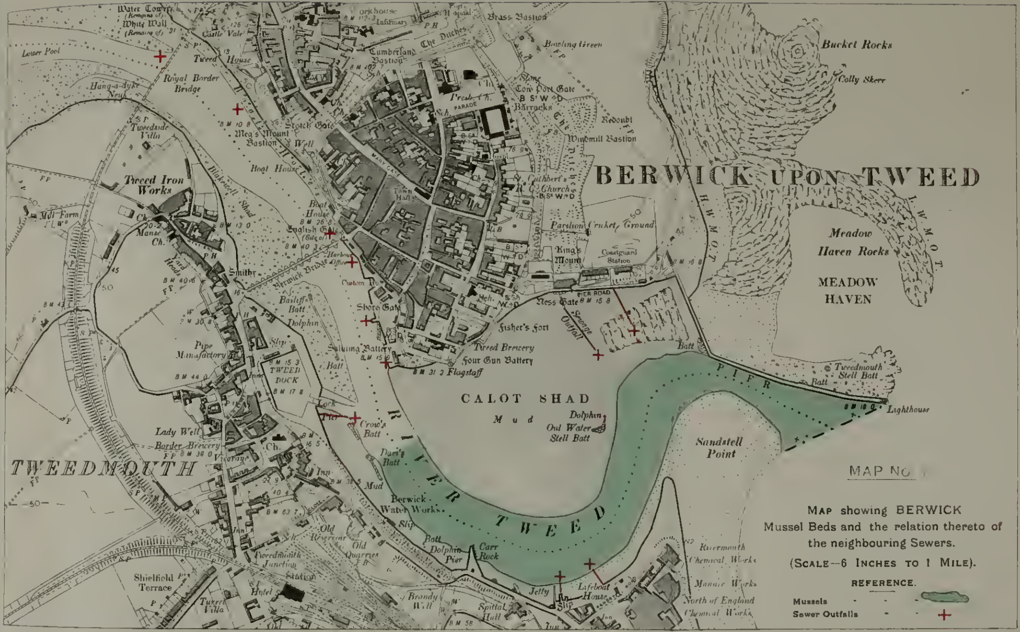
(Scale—6 Inches to 1 Mile).

REFERENCE.

Mussels - - - 🟩

Sewer Outfalls - - +

Ordnance Survey, Southampton, 1910.



MAP No.

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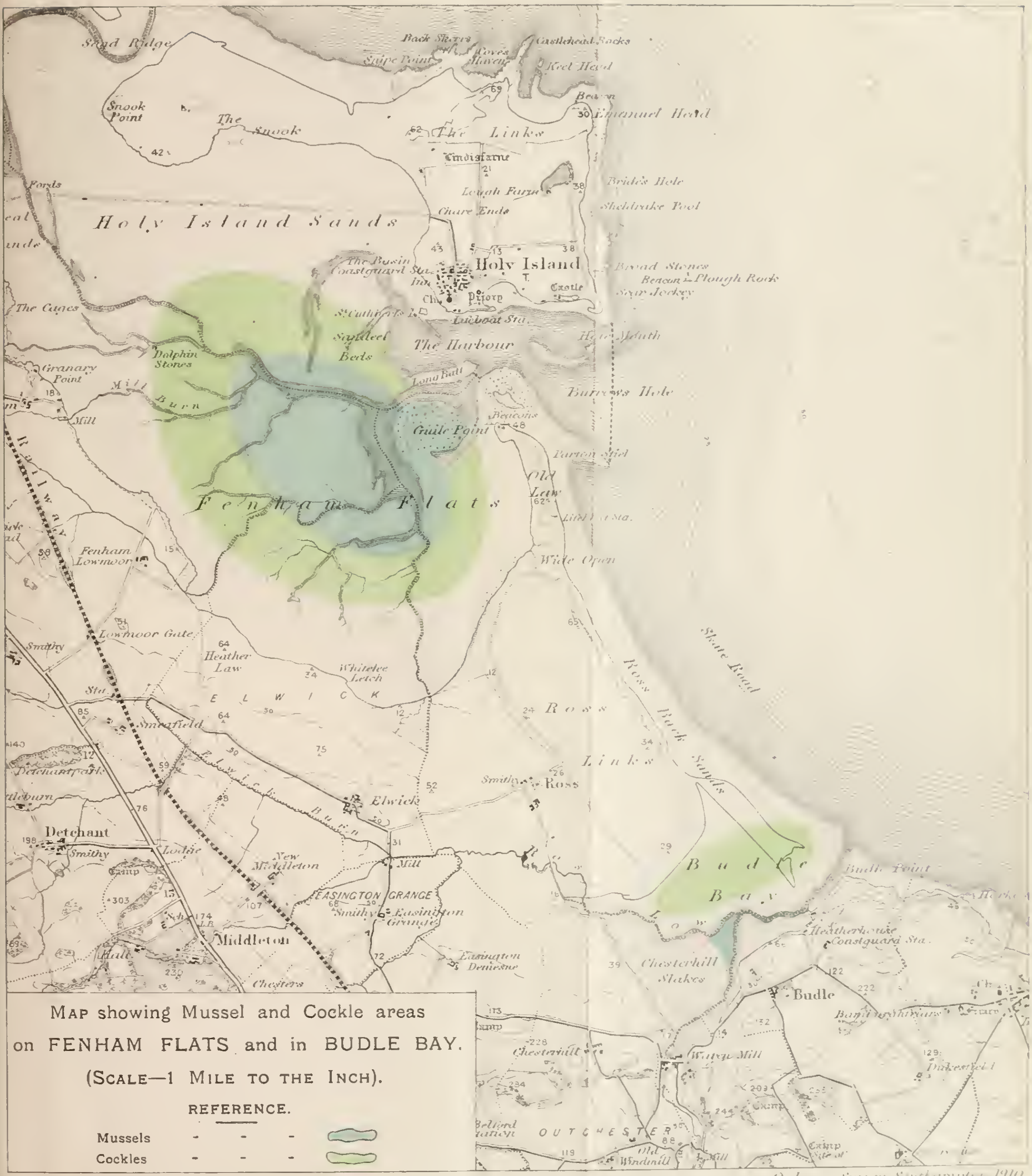
REFERENCE.

Mussels . . . 🟩

Sewer Outfalls . . +

Ordnance Survey, Southampton, 1910.

MAP No. 4.



Map showing Mussel and Cockle areas on FENHAM FLATS and in BUDLE BAY.

(Scale—1 Mile to the Inch).

Ordnance Survey Southampton 1910

THE HOLY ISLAND COCKLE INDUSTRY. (Map No. 4.)

There is a considerable area of cockle sand in this vicinity, and it embraces not only the portion coloured green on the map, but also much of that coloured blue. The cockles, which are extremely fine ones, are collected mainly by women, and the shellfish are sent in their shells to Newcastle and Berwick-upon-Tweed, as well as sold locally in Holy Island.

The cockles are collected by means of rakes or hoes, but there are no byelaws in this district relative either to the size of the cockles or to periods when they may not be gathered.

BUDLE BAY MUSSEL BEDS. (Map No. 4.)

These beds, which are leased to Mr. Mitchell, of Bamburgh, and worked under his supervision, extend over the area shown on the accompanying map, and mussels here collected are despatched from Belford Station for use as food in Newcastle and the pit towns in the neighbourhood, as also to Norwich and Durham, with its surrounding colliery districts.

Mussels for bait are also furnished to the fishermen at Berwick-upon-Tweed when the mussel supply there is insufficient for the local needs. Bait mussels are also sent to Seahouses, Beadnell, Newtown, and other fishing places on the Northumbrian coast.

The cultivation of the Budle mussels has been undertaken for several years past with varying degrees of success, the smaller mussels on the flats being moved down systematically into one or other of the two channels shown on Map 4, in order that by continuous submersion in the water and by a constant supply of food they may grow better than would be the case were they left uncovered for several hours in each tidal cycle.

The Budle Bay Cockle Industry. (Map No. 4.)

Cockles are collected over the area coloured green on the map, and are despatched in their shells to Newcastle and the surrounding districts.

Within recent years cockles were supplied from this source to Norwich and Sheffield, but they are not being sent there at the present time. Some years ago an endeavour was made to reduce the cost of carriage by despatching the cockles, in the boiled condition, without their shells, in the same manner as is the custom at Leigh in Essex and in the Gower peninsula in South Wales. The experiment did not, however, answer the expectations formed of it.

Sometimes as many as 70 persons have been engaged in cockle gathering for this area, but the trade is not so extensive as formerly. Only five tons had been despatched during 1908, at the time of my visit in December.

The Pollutions reaching Budle Bay.

This bay is, as will be seen from the map, in a relatively unpopulated district, and it is obvious that such pollutions as reach its waters are small in extent and remote in distance.

It will be noted that the mussel area proper is largely made up of the convergence of two streams—the Ross Low and the Waren Burn.

The only pollution of any volume which can reach the Ross Low is the effluent from the Belford sewage (population, 800), which, as the river runs is from six to seven miles from the mussels.

As regards the Waren Burn, the nearest source of pollution is from a group of 10 houses at a hamlet known as Waren Mill, which is situate about a mile from the nearest mussels. Having regard to the proximity of these houses and to the drainage which reaches the Burn therefrom, it would be a desirable precaution to despatch no mussels from Waren Burn direct to market, but to submit them to a process of quarantine, either in the oyster pond near or on the foreshore above low-tide level. It has to be borne in mind that during periods of flood, accumulated refuse may be carried down the stream.

ALNMOUTH MUSSEL BED. (Map No. 5.)

The only mussel bed in this locality at the present time is practically the remainder of one which may have flourished in the days prior to 1806, when the channel of the estuary took a different course to the sea than is now the case.

In former years the channel passed to the south of the Church Hill, instead of, as now, to the north of it, there being at one time a low ridge connecting Church Hill with Cheese Hill, where the town now stands.

Consequently, the mussel bed now occupies what is in effect a *cul-de-sac,* formed by the closed channel of the old river, and the mussels instead of, as formerly, being covered with water for long periods and, therefore, supplied with food for several hours, are entirely out of water for a considerable proportion of each tide.

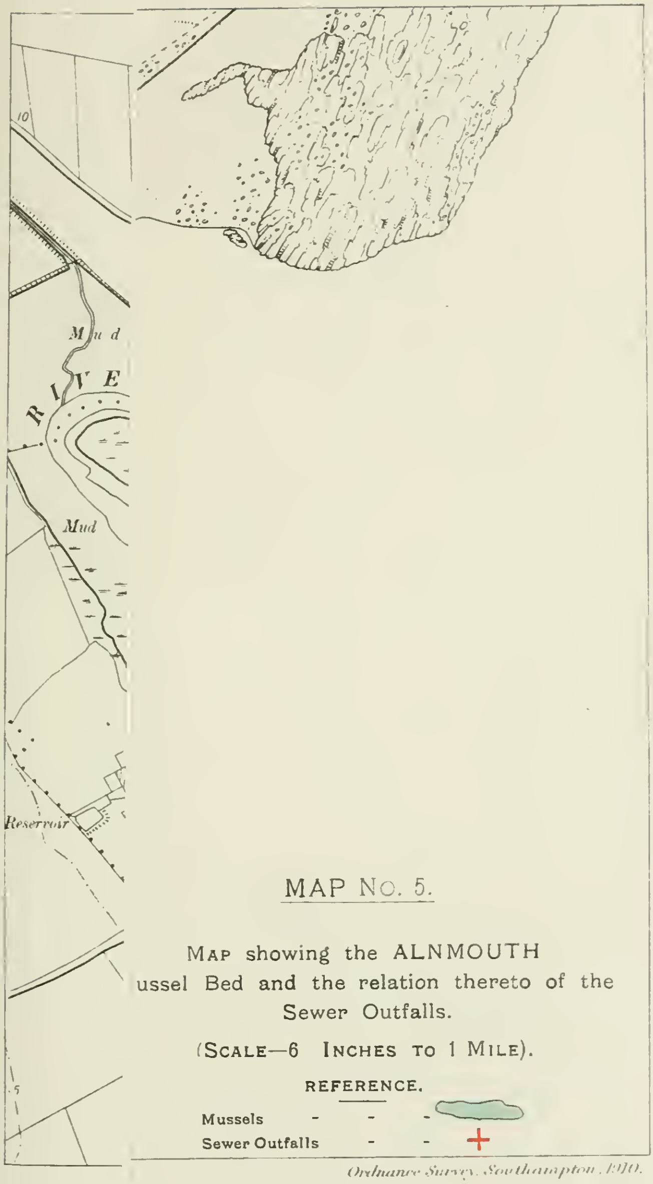
The mussels are small and thin and, relatively, useless either for bait or food.

Efforts were at one time made to transplant the mussels to another portion of the river, nearer the bridge, but no success appears to have attended the experiment, and mussels for bait are now imported from Morecambe Bay.

The Pollution of the River Aln.

The sewage of Alnmouth enters the channel of the Aln in the manner shown on the accompanying six-inch map (No. 5), there being three separate outfalls. I am informed by the surveyor that the population of Alnmouth varies from about 600 in winter to, perhaps, 1,700 in summer; excrement disposal being entirely by water-closets, and the sewage being untreated. It is estimated that in summer the sewage of about 700 persons is discharged by each of the outfalls nearer the sea, while the sewer near the bridge drains a population of about 300.

Although the sewage from these outfalls is relatively small in amount, and it can only gain access to the mussel bed when in

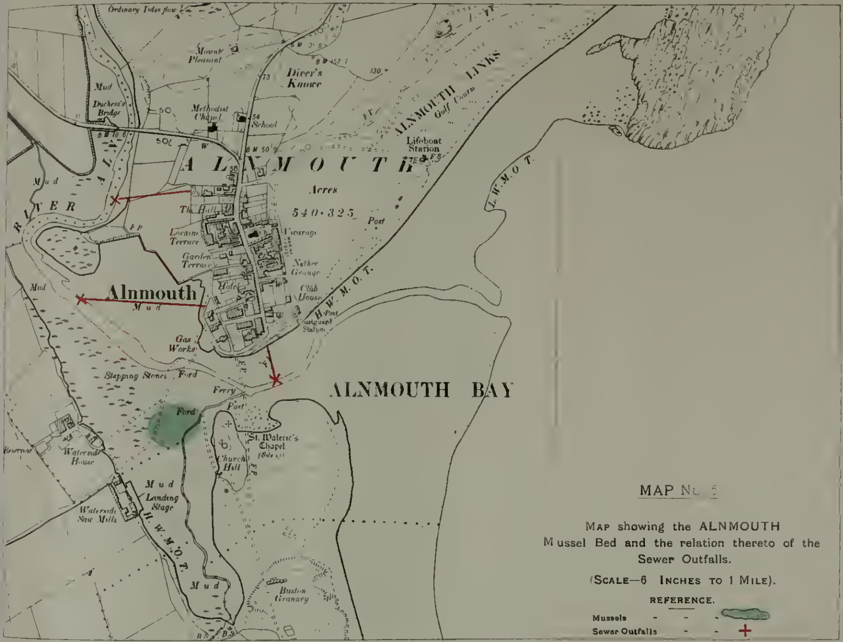


MAP No. 5.

MAP showing the ALNMOUTH
ussel Bed and the relation thereto of the
Sewer Outfalls.

(SCALE—6 INCHES TO 1 MILE).

Ordnance Survey, Southampton, 1910.



MAP No 5

MAP showing the ALNMOUTH Mussel Bed and the relation thereto of the Sewer Outfalls.

(SCALE—6 INCHES TO 1 MILE).

REFERENCE.

Mussels - - - 🟩

Sewer Outfalls - - +

Ordnance Survey, Southampton 1910

a state of great dilution, the risk of contamination from this source is not altogether negligible, and it would be unwise to collect mussels for human food from this locality. About five miles inland there enters the River Aln the effluent from the settling tanks and sewage farm of Alnwick, a water-closet town, with a population of about 6,800. I am informed, however, by the medical officer of health—Dr. Robson—that the farm has for some years been sewage sick, and that the filtrate enters the river practically unchanged.

I have not been able to ascertain that the consumption of mussels in this district has ever been suspected of carrying enteric fever; in fact, very few mussels appear to be eaten, the beds having for a long time been utilised for bait only.

THE AMBLE MUSSEL BEDS. (Map No. 6.)

The chief mussel bed, at the mouth of the Amble River, is situated to the west of the south pier, in the position shown on map No. 6. Hereabouts the mussels are thickly packed, and cover a considerable area. But at the time of my visit in November, 1908, the mussels which I examined were in a poor condition, and they would certainly not have found a ready market for use as human food. They are, I understand, sometimes used for bait, two mussels being attached to each hook. Certain of these mussels have been transplanted to the northern side of the river, with the view of ascertaining whether the locality indicated in blue is suitable for the growth of mussels. The experiment is, I am told, proving a success.

Liability to Pollution.

Practically the whole of the sewage of Amble, with a population of about 5,000, is discharged into the harbour, in close proximity to the mussel bed on the south, and, as the tide rises, the sewage can be seen to be washed back over the mussels. The mussels from this bed must, therefore, be regarded as quite unsuitable for human consumption, owing to the opportunities which are afforded them of becoming specifically contaminated by sewage.

Dr. Stumbles, the medical officer of health of Amble, who was good enough to afford me valuable assistance, tells me that he has had no reason to ascribe any cases of enteric fever to the consumption of shellfish.

THE BLYTH MUSSEL BEDS. (Map No. 7.)

At the present time the most important mussel bed of the River Blyth is situated about three miles inland from the mouth of the river, that is to say, off the village of Cowpen, in the position shown on map No. 7.

At the date of my last visit (November 28th, 1908), when I was accompanied by Dr. Cromie, the medical officer of health, and Mr. R. Grieves, the surveyor, there were five men collecting mussels from the bed, three on the Bedlington side and two on the Blyth side. We also met one mussel gatherer who had just left the bed and who was carrying home mussels to eat. We were informed that on some occasions as many as 50 persons have been seen collecting mussels here, and that the mussels so collected were sold, locally, both for bait and human consumption. The mussel gatherers come from Blyth, Bebside, Bedlington, and, at times, from Newbiggin. The mussels are used in these places, and some are, we were told, sometimes sent by train to North Shields.

Pollution of the River Blyth.

Blyth is one of the most important coal-exporting centres in the United Kingdom. Its population (estimated, 1909) is about 29,090, and a large number of vessels of large tonnage enter its harbour, in which there is a great depth of water even at low tide. Above Blyth, in the position occupied by the chief mussel bed, there is at low tide but a small volume of water.

In the harbour at Blyth the whole sewage of the town discharges untreated, and at all times, by several separate outfalls, and there must be some pollution to the river from the numerous large vessels which visit the port. Although excrement disposal at Blyth is mainly by means of privies, there is now a considerable number of water-closets—perhaps, about one-sixth of the population being thus served—and there is, of course, the slop-water from the whole population to be considered. These facts render it obviously unsafe to collect mussels for human food in the neighbourhood of the sewer outfalls, and clearly the harbour proper ought not to be used as a place from which to collect mussels for food.

But the mussel bed at Cowpen is exposed to pollution in a more direct and, in my view, more dangerous fashion than from the carrying up of the Blyth sewage on the flowing tide.

There is discharging, practically, into the mussel bed the drainage from the isolation hospital, which is situated on the bank above the bed, and at the date of my visit I saw a man collecting mussels (for bait, he stated) within a few yards of the hospital drain. This drain might in epidemic times take the sewage of some 40 patients, and although the excreta are ordered to be disinfected, and the sewage is said to be liberated only at the commencement of the ebb, it is indisputable that the danger of pollution of the mussels from this source is considerable.

There are, moreover, three other sewers discharging dangerously near this bed.

The Cowpen New Town sewer, sewering a population of about 500, discharges into a rivulet, which joins the river a short distance landward of the mussel bed, and more landward still, as shown on the map, another rivulet takes the sewage from a population of some 2,000 persons. Both these streams contained at the date of my visit water which was highly polluted with sewage. There can be no doubt that no mussels for use as human food should be collected anywhere in the estuary of the Blyth.

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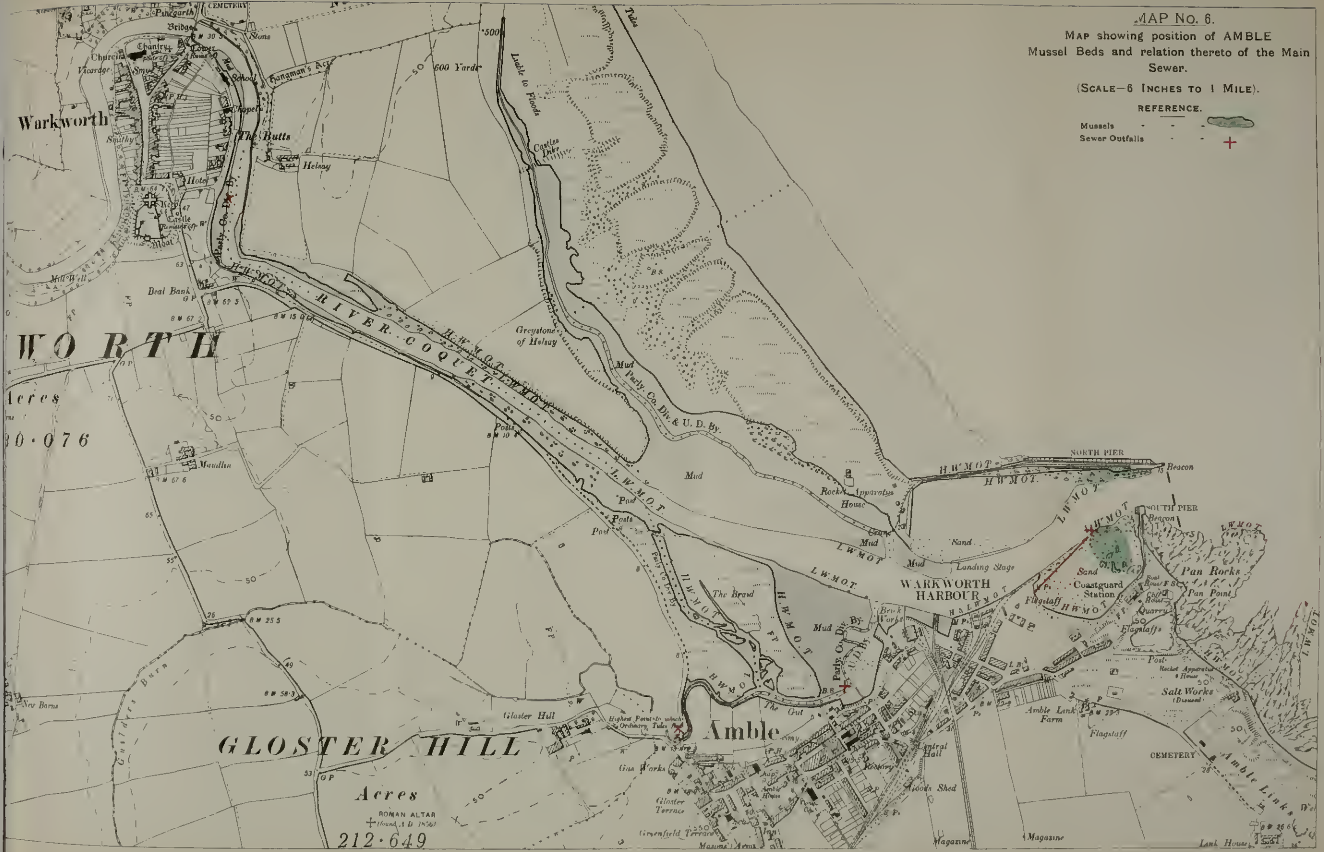


MAP No. 6.

Map showing position of AMBLE Mussel Beds and relation thereto of the Main Sewer.

(Scale—6 Inches to 1 Mile).

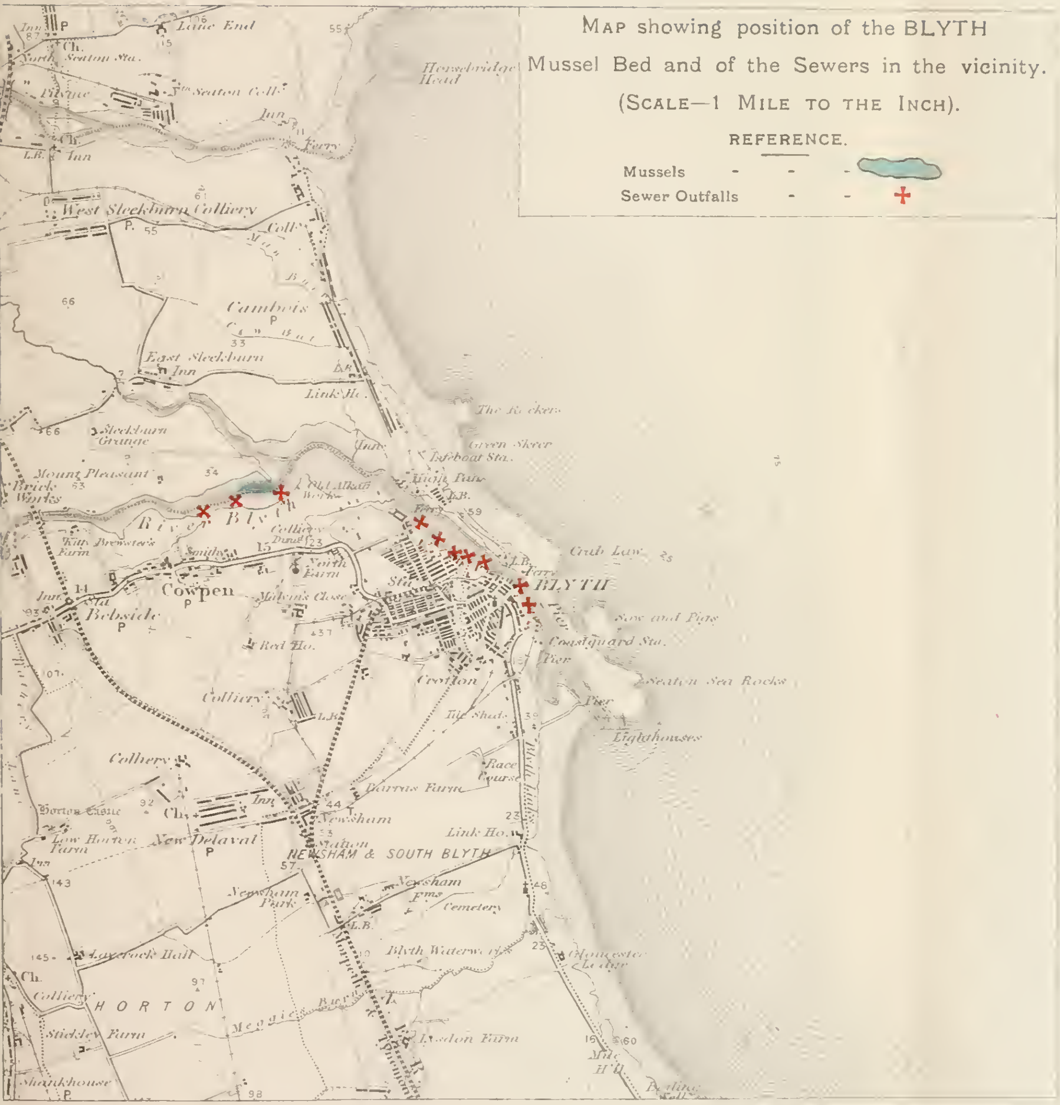
REFERENCE.

Mussels - - - 🟩

Sewer Outfalls - - - +

Ordnance Survey, Southampton 1910

MAP No. 7



MAP showing position of the BLYTH Mussel Bed and of the Sewers in the vicinity. (SCALE—1 MILE TO THE INCH).

Ordnance Survey, Southampton 1910.

Epidemiological Evidence as regards the Blyth Mussels.

About 11 years ago, some attention appears to have been called to the Blyth mussel beds, owing to the occurrence of cases of enteric fever amongst persons consuming mussels taken from this locality.

From a report upon the subject, made by Dr. Hembrough, the county medical officer of health, I gather that the mussel bed in question is partly natural and partly due to transplantation of mussels from other localities by the Northumberland Sea Fisheries Committee. This bed was much increased in size in 1893, soon after which, and notwithstanding the watchers stationed to protect the mussels, large quantities were stolen, and sold, both in a raw and cooked condition, for human food in the neighbouring colliery villages.

In the year 1895, about six cases of enteric fever came to the notice of two of the local medical officers of health, the disease in each instance being attributed to the consumption of Blyth mussels eaten raw.

In each case, Dr. Hembrough reported, the patient had eaten raw mussels from this source, whilst other members of the family living and working under the same conditions and consuming the same milk and water but who had not consumed any uncooked mussels escaped, and there were no other sources of infection which could be discovered. From further inquiries then made by Dr. Hembrough, it appeared that, except in seven sanitary districts, mussels were practically unknown as an article of food.

The case of one family is quoted in which the one member who escaped enteric fever was the only one in the house who had eaten uncooked mussels.

In October, 1897, Mr. J. Cromie,* the medical officer of health to the Blyth Port Sanitary Authority, reported the occurrence of cases of enteric fever which had resulted from the consumption of uncooked mussels collected from mussel beds in close proximity to the drain serving the isolation hospital.

Notices have from time to time been posted near the mussel beds warning the public of the danger incurred by eating the mussels. Such notices have not, however, prevented the collection of mussels for food from the locality, although I was unable to hear of any recent cases of enteric fever which had been attributed to the mussels in question.

THE MUSSELS IN THE ESTUARY OF THE WEAR AT SUNDERLAND.

Although there are, I understand from Dr. Renney, the medical officer of health of Sunderland, no definite mussel beds in this estuary, these molluscs are found growing on the quay walls, in the bed of the river, on the Potato Garth (a little above the harbour entrance), on the rocks on the foreshore both on the north and south side of the harbour, and at the south outlet of the Hudson Dock on the boulders uncovered at low tide.

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* *Lancet*, October 23, 1897.

Dr. Renney tells me that it is particularly on the foreshore that men and women gather baskets full of mussels for sale, but, in addition to this, numbers of people collect them on their own behalf.

Risks of Contamination.

Dr. Renney states that in nearly every case the mussels are exposed to pollution from sewage, some of the localities from which they are gathered being close to sewer outfalls.

Epidemiological Evidence.

In the year 1908, 12 cases of enteric fever out of 132 notified gave a history of mussel eating at a sufficiently recent date to raise suspicion that they were the probable cause of the illness. In some of these cases there was diarrhœa and vomiting, which subsided and, after an interval, symptoms of enteric fever supervened.

For further details relative to enteric fever in Sunderland, see page 79.

THE SHELLFISH INDUSTRY IN TEES BAY.

(Map No. 8.)

Before dealing with the shellfish industry in this locality, a few words as to the topography and extent of the bay here in question are desirable.

It will be seen by the 1-inch map, No. 8, that the estuary of the Tees, shortly after passing Middlesbrough expands into a bay some 5 miles long and, at its widest part, 3 miles broad. At high water, therefore, this bay takes the form of, what is in effect, a small inland sea.

But at and near low tide, the main channels alone contain water, the Seal Sands and Gare Sand, on the Durham side, and the Bran Sand, on the Yorkshire side, being dry for several hours at each tide.

I am informed by Mr. Amos, Secretary of the Tees Conservancy Commissioners, that the main channel of the Tees has been dredged to a minimum depth of 15 feet at low water, the depth at high water being about 30 feet.

But even landward of Redcar Wharf, low-tide soundings of 4 fathoms are recorded on the chart, and off the entrance to Greatham Creek as much as 7-8 fathoms. The width of the channel below Middlesbrough is about 800 feet, and near the mouth of the estuary, nearly half-a-mile. The velocity of the tidal current is about four knots per hour.

These facts are material to a proper appreciation of the amount of dilution to which the slop-water of Middlesbrough and other places is subjected in the estuary before it can reach the shellfish beds. It is no doubt very great. The sides of the channel in the bay itself are for the most part hard and clean, but at places outside this channel, both on the Yorkshire and

Durham side there is much mud, due, apparently, to the deposit under relatively stagnant conditions of the matter in suspension brought down by the waters of the estuary.

This mud is at times well over the boot tops in certain places, but there are large expanses of quite clean sand on either side.

The amount of shipping in the Tees is considerable and increasing.

The Mussel Industry.

In former years the estuary of the Tees was one of the main sources from which the fishermen on the east coast of England,* and even on the east coast of Scotland, obtained their mussel bait, but although a considerable amount of mussels are still procured from this source, both for bait and human food, the industry is of much smaller proportions than formerly.

For instance, on November 12th, 1908, when I last visited this estuary and when I was accompanied by the late Captain Simpson, of the North-Eastern Sea Fisheries District, in the steamship "St. Quintin," there were under 20 boats, in all, engaged in the collection of mussels.

Some of these boats had come from Stockton, others from Middlesbrough, and others, again, from Hartlepool. Some of the boats carried two men, others one.

At that time the majority of the mussels gathered were for human food, but, occasionally, the fishermen from Whitby and other places on the Yorkshire coast, as well as from Hartlepool, on the Durham coast, come to the Tees for mussels to be used as bait, such mussels being stored locally until they are required for bait.

The Area over which Mussels are mainly found.

On either side of the Tees estuary, for many miles, are walls of slag, constructed mainly with the view to the maintenance of the channel, and from a little seaward of Middlesbrough down to near the mouth mussels may at places be gathered. But the more important mussel areas are found in the localities coloured blue on the map (No. 8), the more productive places being on the Yorkshire side of the channel.

In the channel itself the mussels are collected by means of dredges, such as are employed by oyster dredgers, or by rakes with long handles, and these rakes are also used in the water on the Yorkshire side of the channel, as well as in Greatham Creek, on the Durham side. At places where the mussels ebb dry, hand-picking is resorted to.

The mussels after being collected are picked over, washed in the channel, taken to Middlesbrough or Stockton, and sold.

For the most part, these Tees mussels are sold locally, *i.e.*, at Middlesbrough, Stockton, Hartlepool, or elsewhere in the neighbourhood, but, according to the returns which I have procured from certain large towns, some of the Tees mussels are sent inland, and on the occasion of a former visit to Stockton, I was informed that these mussels were sent to places such as Newcastle, Manchester, Bradford, Leeds, Halifax, Shields, Sunderland, Eyemouth, Dundee, and other towns, those going to the inland places being mainly for food, those to the coast towns for bait. It was said, indeed, that at that time, the Tees supplied bait from Aberdeen to Scarborough, at which place the influence of the mussels from the Wash is felt; and Dr. Horne, medical officer of health of Stockton, tells me that now only about 18 cwt. of mussels are brought into Stockton weekly, and that they are sent in small quantities to Bishop Auckland, Durham, Darlington, Spennymoor, Ferryhill, Sunderland, and West Carnforth.

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* Reports on the Mussel and Cockle Beds in the Estuaries of the Tees, the Esk, and the Humber, by Professor McIntosh, M.D., LL.D., F.R.S., &c., 1891.

I gather, however, from the evidence given by Mr. St. Quintin,* Chairman of the North-Eastern Sea Fisheries Committee, and also from Capt. Simpson, that the Tees mussels are not now nearly so good as formerly, and, consequently, that supplies are obtained elsewhere. Moreover, it appears that the fishermen are now in the habit of using escallops for bait in place of mussels.

The Cockle Industry.

Cockles are gathered over the extensive sand areas shown on the map, the localities being approximately indicated by green colouration.

The cockle industry, like the mussel industry, is less extensive than heretofore, but, nevertheless, a considerable amount of cockles are collected, more especially over the Seal Sand during the summer months.

Dr. Dingle, the medical officer of health of Middlesbrough, who was good enough to make some inquiries for me upon the subject, tells me that in the summer time, when, presumably, the demand for cockles is greater than in the winter months, about three boats, containing together about 20 girls, are engaged in cockle gathering, the cockles being taken, mainly, to Hartlepool.

There is, however, a winter trade in these Seal Sand cockles, and on November 12th, 1908, I found six persons engaged in shellfish gathering on these sands. Some were collecting cockles, others periwinkles, and in each case the molluscs were being taken to Hartlepool.

Dr. Horne, the medical officer of health of Stockton-on-Tees, tells me that a few cockles, perhaps 50 cwt. annually, are brought into Stockton occasionally and sold there.

The Pollution of the Tees.

In so far as the shellfish in the Tees are concerned, the main pollution is that which reaches the river from the town of Middlesbrough, a busy and growing manufacturing centre, with an estimated population of 103,511 (1908).

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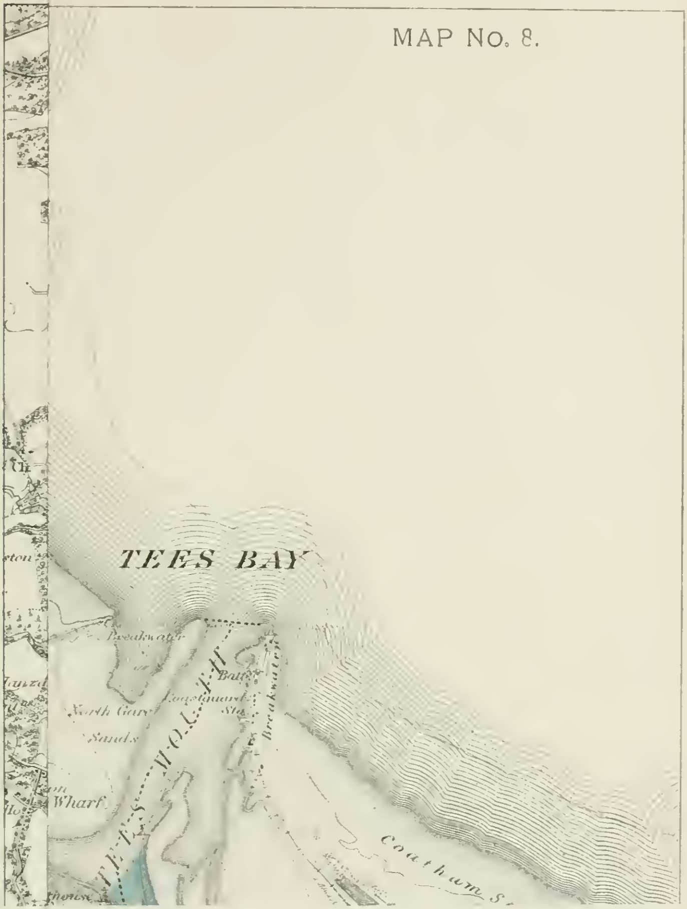
* Minutes of evidence given before the Committee on the Fishing Industry of the United Kingdom, 1908. Wyman & Sons, Ltd., London.

MAP No. 8.


TEES BAY
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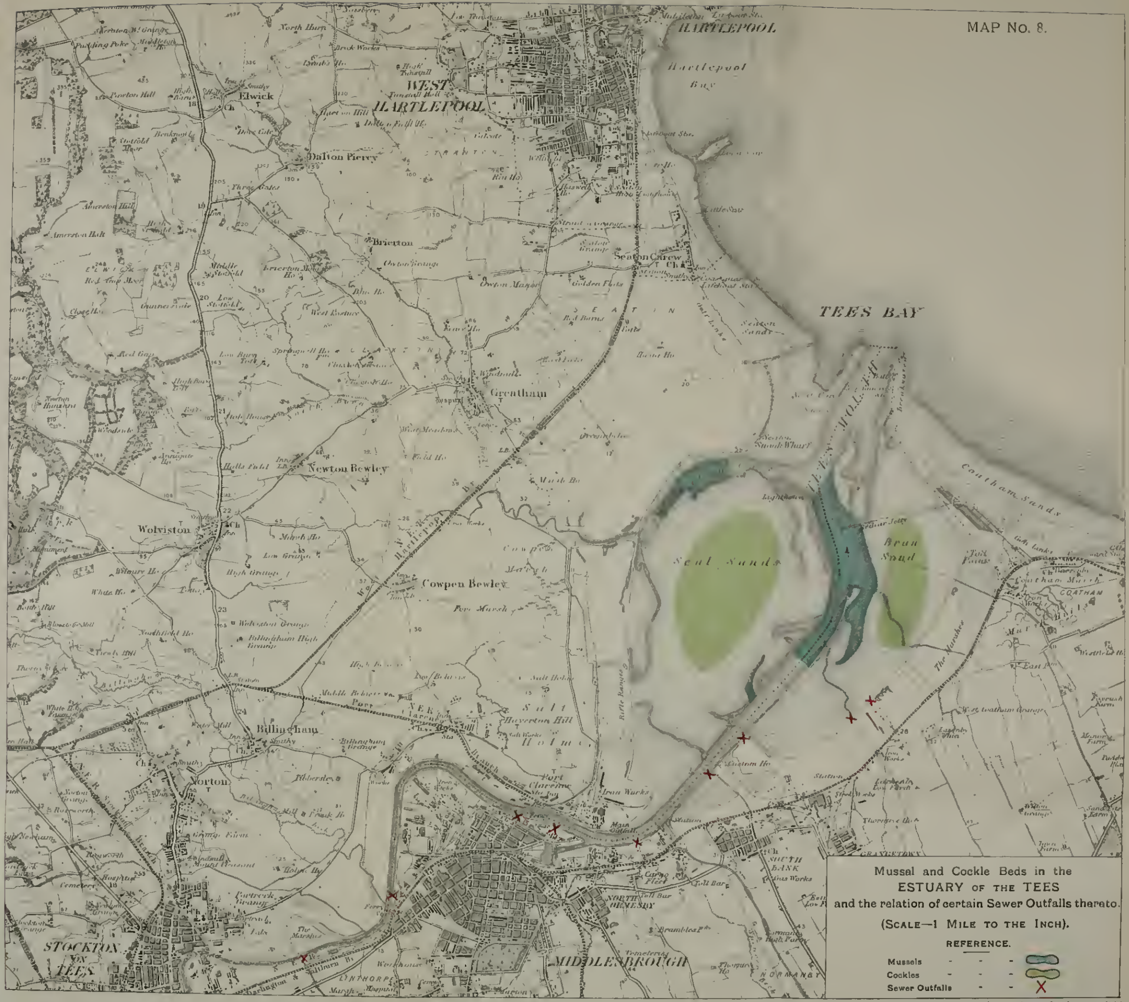
MAP No. 8.



Mussel and Cockle Beds in the ESTUARY OF THE TEES and the relation of certain Sewer Outfalls thereto.

(SCALE—1 MILE TO THE INCH).

Ordnance Survey, Southampton, 1910.

The method of excrement disposal in Middlesbrough is mainly by privy middens and pail closets, but there is in process a gradual conversion of the conservancy into the water-carriage system.

The slop water and storm water, together with such actual water-closet contents as at present exist, are discharged untreated into the Tees by several separate outfalls, but by far the most important one, both as regards amount and proximity to the shellfish grounds, is that which discharges alongside Cargo Fleet, immediately to the east of Middlesbrough. This sewer takes the greater part of the drainage of the town, and at the date of my visit, which was at about half-tide on November 11th, 1908, the sewer was running about half-full.

The sewage at that time contained a considerable quantity of fæcal matter the presence of which was attributed to the contents of the sewer having been held up during the flood tide. The sewage gave rise to a well-defined discolouration around the outfall, and this discolouration could be traced seawards about 400 yards from the outfall, when its presence became unrecognisable to the naked eye from the deck of the steam launch from which the observations were made.

Immediately alongside this outfall is the creek known as Cargo Fleet, where some of the fishermen disembark their mussels. At the time of my first visit there was very little water in this creek, but such water was highly polluted with the sewage which had backed up into the creek. I visited this creek later on in the same day—on the flowing tide—and although it then contained a greater quantity of water its condition was eminently unwholesome. I was told by one of the mussel gatherers, when I raised question as to the unwashed condition of some mussels which were being bagged on the mussel grounds, that they, the mussels, would receive further washing in Cargo Fleet. It was, however, denied by others that any washing of mussels took place at Middlesbrough, and it was asserted that the molluscs were washed as the boats returned to the town. From what I have seen, as regards the washing of mussels elsewhere, it appears to be highly desirable that a careful watch should be kept upon the practice adopted in the Tees, as special circumstances might not improbably lead to the routine practice being not observed. Dr. Dingle was good enough to have some observations made with regard to the landing of mussels in Cargo Fleet, and from the practice observed in certain instances it was inferred that no washing of mussels takes place therein. In my view, however, it would be better were no mussels allowed to be landed at the place in question, seeing that opportunities for their specific pollution might so easily occur. There is, I fear, a suspicion that at times the mussels, which are taken to Stockton, are washed in a creek which is polluted.

It will be seen that the site of the main Middlesbrough sewer is some 2½ miles from the locality from which the mussels are for the most part collected. But it has to be observed that there are no regulations against the gathering of these molluscs from the slag walls much nearer the main outfall.

Moreover, in addition to the Middlesbrough outfalls, there are others nearer the main mussel beds, notably so, the South Bank in Normanby main sewer, which discharges to the west of Eston Jetty, and the two Eston outfalls, one of which discharges slop water into the channel within about a mile of the mussel beds, and the other of which discharges high up on the foreshore, within less than a mile of certain of the mussels. There is, too, I understand, another outfall a little further seaward.

In addition to these (mainly slop water) outfalls which enter this bay, there is discharged further inland the slop water of Thornaby and Stockton-on-Tees.

It has to be borne in mind that all these towns deal with their excrement largely on what is known as the conservancy system, but this notwithstanding, a considerable amount of excrement must enter the Tees from the increasing number of water-closets, through the agency of slop water and also through that of the shipping. For instance, at Stockton-on Tees, Dr. Horne informs me there are over 3,500 water-closets and nearly 7,000 privies.

Having regard to the enormous volume of water hereabouts, the degree of risk to which the mussels, gathered over the area coloured blue are subjected is not, perhaps, a high one, but, nevertheless, risk does in my view obtain, and so long as the Tees mussels are used as human food, risk must attend their consumption in the raw or partially cooked condition.

Such risks might be, of course, entirely removed by restricting the use of Tees mussels to purposes of bait, and they might be lessened by proper regulations as to the collection and washing of shellfish and by the diversion of some of the nearer slop-water sewers from the estuary direct to the sea.

The cockles are less exposed to the risks of specific pollution than the mussels, seeing that the sand banks from which they are collected are only covered with water when the flowing tide has forced back any pollution in the channel, while, as regards the ebb tide, the trend of the current would be likely to deflect polluted water from the sandbanks.

At the present moment, there is no control over the collection of shellfish in the bay, and cockles or mussels can be gathered anywhere, at any time, and of any size, whether for human food or as bait.

The North-Eastern Sea Fisheries Committee formerly expended a large sum of money in efforts to foster the mussel industry for purposes of bait, and a large amount of mussel transplantation was undertaken into Greatham Creek around the "Stones," on the Yorkshire side, and elsewhere, but owing to the disappointing results, all control of the shellfish industry in the estuary has now been abandoned.*

One result of this abandonment is that uncontrolled dredging for bait and food takes place, and, consequently, the Tees Conservancy Commissioners have taken steps to acquire powers for administering the Tees Shellfish Order of 1902, and the powers so sought are embodied in Tees Fishery Order, 1909.

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* *See* evidence of Mr. St. Quintin already referred to.

Epidemiological Evidence as regards the Tees Shellfish.

Efforts to obtain evidence indicating that shellfish derived from the Tees have been instrumental in conveying enteric fever have, so far, led to the following results.

Dr. Dingle, the medical officer of health of Middlesbrough, who is familiar with the conditions under which the local shellfish industry is carried on, had not, at the date of my visit, been able, during his long period of office, to associate any of the extensive prevalence of enteric fever in Middlesbrough with Tees shellfish.

I gather, however, from a report in the "Northern Daily Mail," of February 9th, 1909, that about that time Dr. Dingle drew the attention of the Tees Port Sanitary Authority to the fact that several cases of enteric fever had recently been attributed to the consumption of Tees mussels, and he suggested that notices should be exhibited near to the sewer outfalls prohibiting the getting of mussels in the vicinity of such sewers. The attention of the Tees Commissioners, who now have jurisdiction over the shellfish was drawn to the matter.

Dr. Horne, medical officer of health of Stockton-on-Tees, states in his annual report for 1907, when discussing the prevalence of enteric fever, that:—"Shellfish was the reputed "channel of infection in two instances. One of the persons "attacked had partaken of mussels and cockles upon dates antecedent to the onset of the symptoms, which made it reasonable "to suspect these events as having causative relationship with "the disease."

Dr. Horne also tells me that from time to time he has had suspicions that enteric fever at Stockton has been due to shellfish, but that it is only recently that the facts ascertained have left no doubt on his mind. He adds, that not infrequently it has only been by close personal enquiry of the patient himself while in hospital that he obtained admission of the fact of eating mussels within the incubative period of the disease.

Dr. Fulton, medical officer of health of Eston, reports that very few cases of enteric fever occur there, and that in all cases careful enquiries are made as regards sources of infection. He states that he has in former cases had a history of the eating of shellfish, but that on October 4th and 9th two cases occurred in which the evidence of the disease having been caused by shellfish gathered on the shore was very strong, indeed, so much so, that he felt bound to draw the attention of the public to the danger.

Both the patients were men who had eaten raw mussels gathered from the same source, *i.e.*, two miles seaward of the Eston sewer outfall. In each case the patient was attacked with vomiting shortly after eating the mussels.

Each of those attacked had raw mussels; while in one family the other members who partook of the mussels boiled escaped infection, although all were more or less indisposed for some days.

Dr. Rawlings, the medical officer of health of Hartlepool, reports that nearly all the shellfish brought to this town are used as bait, very little being employed for human consumption. He has never been able to attribute any cases of enteric fever to shellfish.

The medical officer of health of Spennymoor Urban District states in his annual report for 1908, that in the early part of the year an epidemic of eight cases of enteric fever, with nine secondary cases, occurred, which appeared to be due to mussels which were said to have come from Stockton; the medical officer of health of which place reported that the mussels were procured from the mouth of the Tees. At the end of the year in question, two more cases of enteric fever occurred, which have been apparently infected by mussels.

Dr. Stainthorpe, medical officer of health of the Guisborough Urban and Rural Districts, and of the Loftus, Skelton, and Brotton, Redcar, and Saltburn-by-the-Sea Urban Districts, reports that very little shellfish is used in any of the districts for which he acts, and no cases of enteric fever have been attributed by him to shellfish.

As already stated in Chapter VI., my colleague, Dr. Johnstone,* has made inquiry into the question of enteric fever at North Ormesby, and from his report relative thereto, it appears that:—

"*Shellfish*, consisting mainly of mussels and periwinkles, are hawked in the streets of North Ormesby. They are usually obtained from the Tees below Middlesbrough, where the river is badly contaminated with sewage. Out of 62 cases in which inquiry was made it was found that 16 had eaten shellfish within a period of 5 to 21 days before the onset of enteric fever. That is 25·8 per cent. of those questioned had eaten shellfish a short time previous to their illness. In order to obtain some figures with which to compare this percentage, a census was made of two or three typical streets in North Ormesby, and inquiries were made as to the consumption of shellfish, ice cream, fried fish, and later on of uncooked vegetables. Inquiries as to shellfish were made at 174 houses, and it was found that in 16 shellfish of one sort or another were consumed in the summer of 1908. 827 persons were interrogated and 60 of them gave affirmative replies. That is in 9·2 per cent. of the houses, and in the case of 7·3 per cent. of the individuals, shellfish had been taken during the summer of 1908. It appears then that amongst those attacked by enteric fever there were more than three times as many persons who had eaten shellfish during the period of 5 to 21 days preceding their illness as was to be expected from the figures obtained at the local census. The disproportion is much more marked when it is considered that the census inquiry included the whole summer, while the inquiry made from patients included only a particular period of 16 days. These figures afford strong presumption that the consumption of specifically infected shellfish contributed to spread enteric fever in North Ormesby during 1908."

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* Dr. R. W. Johnstone's Report to the Local Government Board upon an outbreak of Enteric Fever in the Urban District of Ormesby. 1909.

Dr. John Glen, medical officer of health of South Bank in Normanby, has seen no instance of enteric fever caused by shellfish in his district, although he has seen cases of ptomaine poisoning following the consumption of the molluscs.

As regards the consumption of shellfish in the County of Durham generally, Dr. T. Eustace Hill, county medical officer, states in his annual report for 1908:—

"The consumption of specifically infected mussels was, in the opinion of several medical officers of health, responsible for outbreaks of the disease. Thus in Spennymoor 17 cases in the early part of the year appeared to owe their origin to the consumption of shellfish, and a bacteriological examination of some of the mussels indicated the presence of bacilli coli in such large quantities as to suggest sewage contamination. A smaller outbreak occurred in the same district towards the end of the year. In the Sunderland Rural District 13 cases of enteric fever were attributed to mussel eating, and smaller outbreaks are reported from the Urban Districts of Houghton-le-Spring, Seaham Harbour, Shildon, and Easington Rural District. From inquiries made by me it is evident that large quantities of mussels which have been collected near the Mouth of the Tees and from other places to which sewage had access were hawked about the country by men out of employment who were trying to earn a livelihood by that means."

In connection with information relative to this area, I am indebted to the North-Eastern Sea Fisheries District Committee and to the Tees Port Sanitary Authority for the use of their steam launches, to Mr. Amos, Secretary of the Tees Conservancy Commission, for charts and assistance, and also to the several medical officers of health whose names have already been mentioned in the foregoing pages.

The following Table furnishes the death-rate from "Fever" per 100,000 *for certain of the Towns consuming Tees Shellfish.*

—	Stockton (53,660).	Middlesbrough. (105,255).	West Hartlepool (79,686).
1894	19	29	15
1895	39	33	24
1896	13	43	10
1897	13	33	20
1898	18	35	7
1899	10	26	19
1900	12	20	8
1901	37	32	10
1902	17	25	14
1903	14	23	6
1904	13	18	4
1905	11	23	10
1906	15	16	8
1907	15	16	3
1908	11	16	6
1909	2	15	4

The Tees Fishery Order, 1909, which provides for the improvement, maintenance, and regulation of an oyster, mussel, and cockle fishery in the estuary of the River Tees, confers certain powers of control upon the Tees Conservancy Commissioners.

This Order enacts that no person shall dredge or fish for or take oysters, mussels, or cockles within the limits of the fishery without a licence. A licence must be granted to any person applying for it, but such licence shall not authorise anyone to collect shellfish over any prohibited area.

Certain payments are to be made to the Commission in respect of the shellfish taken, *i.e.*, for every 132 oysters or less, 1*s.*; for every cwt. or less of mussels 6*d.*; but no royalty is as yet to be paid for cockles.

It is possible that under the provisions of this Order an improvement might be brought about in the conditions under which shellfish are now collected in the estuary of the Tees.

THE SHELLFISH INDUSTRY IN THE HUMBER.

In former years there was a large trade both in oysters and, to a less degree, in mussels in the Humber, and there were on the foreshore between Grimsby and Cleethorpes extensive layings, upon which oysters, largely foreign, were stored for use during the close season for native oysters in this country. These layings were undoubtedly liable to pollution, as also were other shellfish collected hereabouts, and prevalence of cholera and enteric fever has been attributed in years gone by to the consumption of these shellfish.

Moreover, at the date of the Board's report upon oyster culture, it was found that some of these molluscs were stored in Grimsby Docks under distinctly dangerous conditions.

As regards the conditions which formerly obtained with reference to the mussels in the Humber, an interesting account will be found in a report, made in 1891 by Professor McIntosh, on the mussel and cockle beds in that estuary.

But at the present time, I am informed by the medical officers of health, both of Grimsby and of Cleethorpes, that there is no shellfish industry within either of these districts, and that the oysters, which were formerly laid down on the foreshore, have been transferred to Hunstanton, on the Norfolk coast, whence they are brought to Grimsby and Cleethorpes as required.

The Cockle Industry off the Mouth of the Humber.

This is now of but small proportions, and only small quantities are collected.

The main site of the cockle industry is over the sands, which are exposed at low water from about a mile southwards of Tetney Haven to a little to the north of Donna Nook Beacon, where the North-Eastern Sea Fisheries District ends and the Eastern District commences.

The cockle gatherers come from Cleethorpes and the villages which lie about three miles inland, *i.e.*, North Coates, Marsh Chapel, Grainthorpe, and Conisholme, and the number of persons engaged is, approximately, as follows:—

Cleethorpes—7 to 8 carts.
Marsh Chapel—1 cart and some handpickers.
Grainthorpe—6 handpickers.
Conisholme—2 to 3 handpickers.
North Somercotes—5 to 6 carts and handpickers.

The amounts collected are estimated by the Fishery Bailiff as follows:—

	Tons.
October to December, 1907...	50
January to March, 1908	30
April to June, 1908...	10
July to September, 1908	5

The cockles are collected with rakes and they are washed in the "runs" which traverse the sands. They are disposed of for the most part locally, but some are sent to Louth and some to Cleethorpes, Grimsby, and Sheffield.

The nearest sewer outfall is that of Cleethorpes, which is fully five miles from the nearest cockle ground, and the sewage from this outfall is discharged under such conditions that the opportunities of any of it reaching the cockle area are so remote as to be practically negligible.

For information relative to the shellfish hereabouts, I am indebted to Captain Simpson, the Fishery Officer of the North-Eastern Sea Fisheries District, and to Mr. Wilson, the Fishery Bailiff.

THE MUSSEL AND COCKLE INDUSTRY IN THE WASH.

(Map No. 9.)

In the waters of the Wash, which is practically a bay of the German Ocean some 20 miles broad, there dry at and near low water numerous sandbanks, upon a large number of which mussels and cockles are gathered.

The jurisdiction as regards mussels in the Wash is vested partly in the Eastern Sea Fisheries Committee and partly in the Town Council of Lynn, while as regards cockles the jurisdiction over practically the whole area belongs to the Eastern Sea Fisheries Committee.

The general distribution of the shellfish in the Wash is indicated by the accompanying map (No. 9) which has been constructed from a chart which Mr. Donnison, the Fishery Inspector of the district, was good enough to mark for me on board the "Protector."

The general method of collection over the whole area is practically identical and is as follows:—

The boats leave Boston or Lynn at such a time on the ebb tide as will enable them to reach one or other of the numerous sandbanks well before low water in order that there may be sufficient water to float their boats to the required position. If the tide has not yet sufficiently ebbed on arrival over the beds the time may be occupied in dredging or raking for the mussels. But when the sandbanks are uncovered the usual method of collection is that of handpicking, the mussels, when picked, being dropped into a small hand net. When this net is full it is a common custom to wash the mussels, while still in the net, in the water adjoining the boat, and then to empty the mussels loose into the boat. Sometimes, however, the washing is not practised, in which case the mussels are brought up to either Boston or Lynn unwashed or insufficiently washed, when they are then dealt with in the manner described later.

The mussels collected over the Wash are either used for human food, for bait for the long-line fishermen, or for the purposes of relaying in the numerous creeks and channels which abound along the Norfolk coast from Hunstanton to Cley, and which will be dealt with subsequently.

No mussels may be collected either for human food or for bait which are under two inches in length as measured by the official gauge of the Fishery Committee. But as regards mussels for relaying special regulations are made from time to time, and public notices thereof issued, in reference to certain of the sandbanks and at those periods small "brood" mussels are taken away in large quantities to the Norfolk "lays," "plantations," or "allotments," where they are allowed to remain until they are of marketable size, when they, too, are despatched either for human food or bait—mainly the former.

Up to about 12 years ago the greater part of the mussels removed from the Wash were used for purposes of bait or relaying, but the introduction by the Eastern Sea Fisheries Committee of the size limit had the effect, Mr. Donnison tells me, of very largely curtailing the bait supply, those mussels which formerly were for bait being now sold for human consumption.

Mr. G. E. Clarke, Ass. M. Inst. C.E., the borough engineer of Boston, has furnished me with the following figures relative to shellfish despatched from Boston during 1908. The total weight so despatched was 1,265 tons of mussels and 27 tons of cockles, and the following towns received the respective amounts:—

Nottingham, 400 tons.	Leeds, 50 tons.
Sheffield, 400 tons.	Doncaster, 50 tons.
Barnsley, 80 tons.	Bradford, 50 tons.

The cockles go chiefly to Sheffield and Cardiff, but the majority go to Cardiff.

As regards cockles, Mr. Donnison has forwarded me the following figures:—

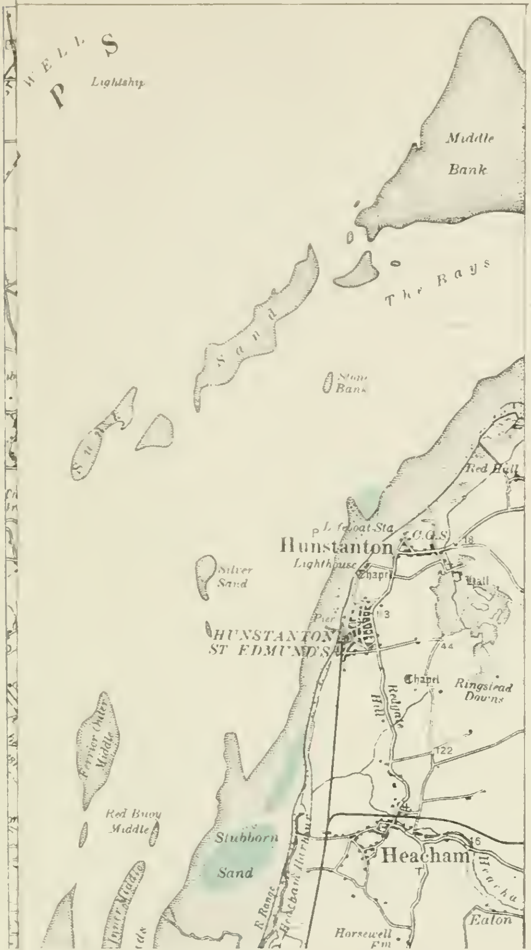
	Cwts.		*Value.*
1907.	18,341	...	£1,146
1908.	17,202	...	£898

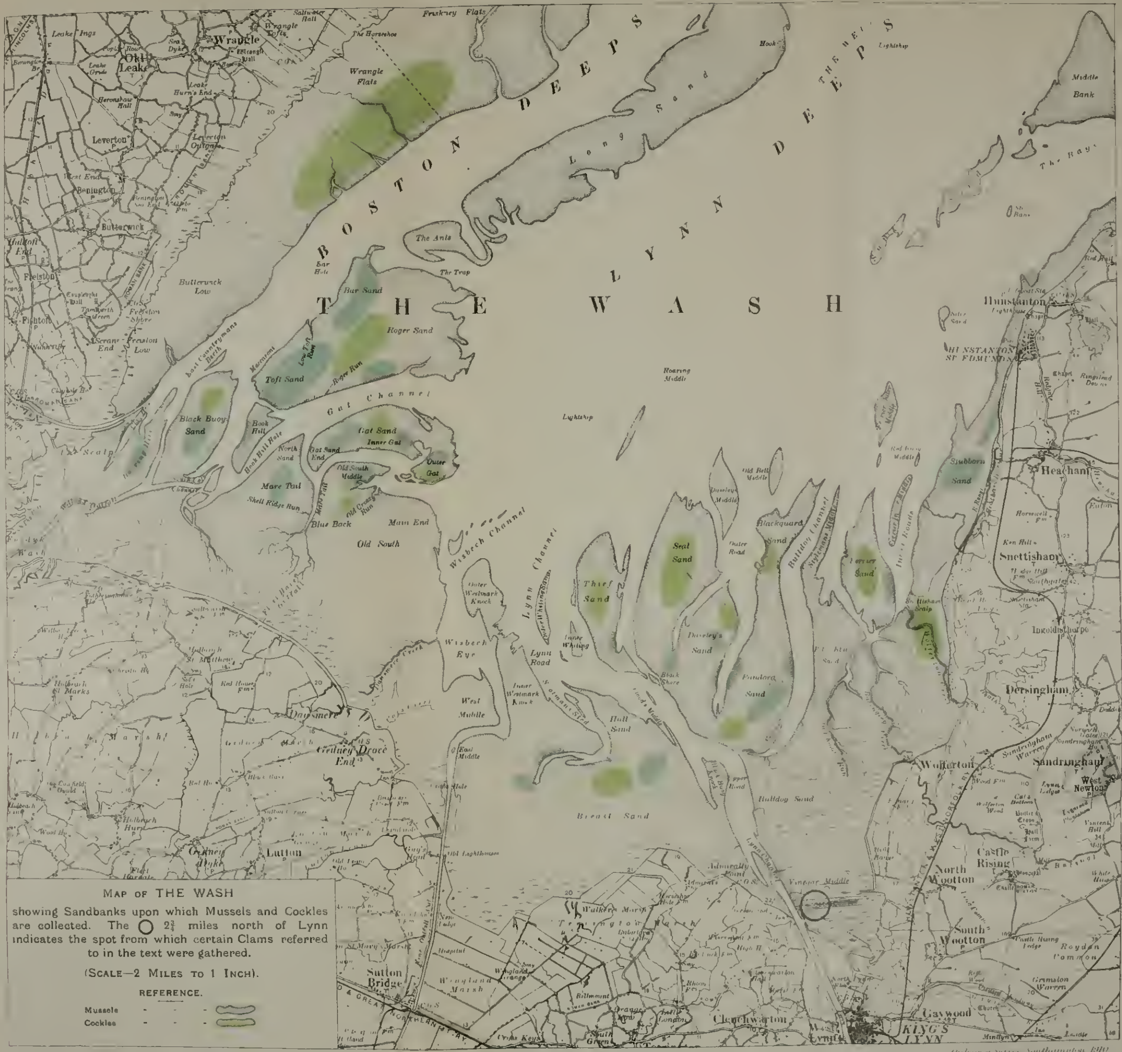
The value of cockles in 1907 was about 1*s.* 3*d.* per cwt., that for 1908 just over 1*s.* per cwt.

The Liability of the Wash Shellfish to Contamination by Sewage in the Wash.

Generally speaking, but excluding the mouths of estuaries to be referred to later, I should regard the shellfish of the Wash as decidedly remote from the risk of specific contamination. There are, of course, several rivers emptying themselves into the

MAP No. 9


WELLS
Lightship
Middle Bank
The Bays
Sand
Stone Bank
Red Hall
Lifeboat Sta
C.G.S.
18
Hunstanton
Lighthouse
Chapel
Hall
Silver Sand
Pier
13
HUNSTANTON ST EDMUND'S
44
Chapel
Ringstead Downs
Redgate Hill
122
Ferrier Outer Middle
Red Buoy Middle
Stubborn Sand
Heacham
15
Heacham Harbour
R. Range
Inner Middle
Horsewell Fm
Eaton



MAP OF THE WASH

showing Sandbanks upon which Mussels and Cockles are collected. The ○ 2¾ miles north of Lynn indicates the spot from which certain Clams referred to in the text were gathered.

(SCALE—2 MILES TO 1 INCH).

REFERENCE.

Mussels - - - ▨
Cockles - - - 🟩

Ordnance Survey, Southampton, 1910

waters of the Wash, *i.e.*, the River Witham, which enters it about five miles below Boston; the Welland, which enters it some eight miles below Spalding; the Nen, which extends some 10 miles northwards of Wisbech; and the Ouse, which joins the Wash some four miles north of Lynn. Each of these rivers brings down slop water and some sewage, and, hence, there may be risk attaching to the consumption of shellfish collected immediately at the mouth of the river, a remark which applies perhaps more particularly to the case of the Ouse and the Witham, which join the Wash in each instance some 3-5 miles from the towns of Lynn and Boston respectively.

But in estimating the degree of such risk it has to be borne in mind that for the most part both the mussels and the cockles are collected on the sandbanks which dry fairly early on the ebbing tide, and which are consequently at a considerable elevation above low water level.

From this it follows that any sewage brought down by the rivers in question at or near low water cannot reach the shellfish banks, and that any sewage which may reach these banks on the flood must be in a state of enormous dilution, so much so, indeed, as to be practically negligible.

Similarly at the early part of the ebb such sewage as reaches the Wash must have undergone an enormous dilution, and the fact that the ebbing tide runs strongest along the main channels has the effect of diverting even this diluted sewage from the sandbanks rather than over them.

Nevertheless, it would, I think, be well to have a series of float experiments and bacteriological examinations (conducted in the estuaries entering the Wash) with a view to determining the nearest point to each of the mouths of these estuaries at which it would be reasonably safe to collect or deposit shellfish.

The necessity for acting in the above sense is emphasised by the fact that some years ago the mussels near the mouth of the River Witham were rendered unsaleable by reason of some creosote which had imparted a characteristic taste to the molluscs collected in this vicinity, and which had gained access thereto from some works at Boston—(see Mr. Donnison's report for the half-year ending March 31st, 1899)—and reference will be shortly made to an outbreak of enteric fever which occurred in the spring of 1900 in the King's Lynn Rural District, and which was attributed by Dr. Plowright, the medical officer of health, to the consumption of clams collected from Vinegar Middle on the east bank of the Ouse, and about 2¾ miles distant from the town of Lynn. (See map No. 9.)

The Cleansing of the Wash Mussels at Boston.

Up to the beginning of the year 1909 it was a common practice to treat the mussels on arrival at Boston as follows:—

The mussels brought up loose in the boats and in an uncleaned condition were transferred to the bags on the quay by a gradual process of washing them in the water of the river. For this purpose the small nets used in the collection of the molluscs were filled with mussels, the nets with their contents being afterwards washed by agitation in the river water. The mussels were then carried on to the quay in the nets and emptied into the bags in which they were despatched to market by train.

This practice, which cannot be regarded as other than an eminently unwholesome and dangerous one, took place at two landing stages. The one at which by far the greater quantity of the Boston mussels arrived was at the landing stage near the swing bridge; the other, at which not more than five to ten per cent. of the mussels was discharged, was at the Fish Quay. The former place was but a very short distance below the main sewer outfall from the west of the town, the other was at a spot in the immediate vicinity of numerous drain outfalls.

But after hearing from me of my proposed visit in the winter of 1908-9, Mr. Herbert Donnison, the Fishery Inspector of the Eastern Sea Fisheries District, decided to take definite action aimed at a discontinuance of this dangerous practice. He was able to obtain the co-operation of the Boston Town Council, and to have tanks, supplied with fresh water, erected at the Fish Quay wherein the mussels could be dipped instead of, as at present, in the polluted river; and at the date of my visit in January, 1909, one of these tanks was about to be erected. Mr. Donnison had also approached the railway authorities with the view of having similar tanks supplied with water from the public water supply erected near the swing bridge.

At Mr. Donnison's request, I saw certain members of the Town Council, as also the medical officer of health and the borough surveyor, both of whom showed themselves thoroughly alive to the seriousness of the position, and expressed a willingness to do all in their power to amend matters. I also saw certain of the mussel merchants, and I explained to them emphatically that unless the practice of "washing" mussels in the river was discontinued it was not improbable that steps would be taken which would be disastrous to the industry.

Action taken in the above senses certainly produced an effect, so much so that I actually saw the mussels from one boat being "bagged" in an unwashed state. But even this was preferable to "washing" them near the sewer outfall.

The Cleansing of the Wash Mussels and Cockles at Lynn.

Up to quite recently the prevailing practice has been to bring the shellfish back to Lynn and to wash and pack them in a creek immediately to the north of the town. I have watched this process on several occasions when one or another of my official duties has taken me to Lynn.

The general practice is to lower the shellfish into the waters of the creek by means of a rope or sometimes by hand and thus to wash them, the shellfish being then either hauled up or brought to land to be packed. Sometimes a pail of water is poured over the mussels when they are bagged. The result of this constant agitation of the creek water is that after a time it becomes very muddy and unsuitable for the purpose to which it is put. But in addition to this objection there is the consideration that the entrance to this creek is not far distant from one of the sewer outfalls, and that it is not improbable that under certain conditions some of the very dilute sewage in the Cut might be carried back by the early part of the flood into this creek. Probably most of the sewage in question would keep in the main channel of the Cut, but there is some risk that at times a small amount might find its way into the creek.

Under these circumstances it is, I think, eminently undesirable to continue the practice of washing the shellfish in the water of the creek.

Shortly after my inspection at Boston Mr. Donnison visited Lynn, and suggested that fresh water tanks should be erected on the lines of those already elected at the Fish Market at Boston. The provision of such tanks of sufficient size, number, and arrangement as to always contain an abundance of clear water would, of course remove the serious objection already raised.

But on the whole, both with regard to Boston and to Lynn, it would, in my view, be a much better course to insist upon the shellfish being washed on the beds, and to prohibit any washing whatever within the estuaries. I expressed this opinion to the Chairman of the Fishery Committee of the Lynn Town Council in March, 1909, when I was fortunate enough to find several members of such committee with the Town Clerk when I called at his office.

Epidemiological Evidence relative to Mussels and Cockles from the Wash.

Dr. Arthur Tuxford, who is medical officer of health for Boston Borough and Port, as well as for the rural districts of Boston and Sibsey, states that although the matter is constantly in his mind in connection with cases of enteric fever, he has been unable to trace any cases in any of his districts to the consumption of shellfish.

Dr. Allinson, who was for several years medical officer of health of Lynn, has not in his annual reports ascribed any of the enteric fever in Lynn to the influence of shellfish, although detailed inquiries relative to the matter were made in each case.

In the early part of the year 1909 Dr. Coleman, deputy medical officer of health of Lincoln, apparently attributed a series of cases of enteric fever in Lincoln to the consumption of mussels procured from a boat which had come direct up the river from Boston, but the allegation does not appear to have satisfied the medical officer of health of Boston. (See annual report for 1909.)

In the spring of the year 1900 there occurred in the Freebridge Lynn Rural District an extremely instructive outbreak of enteric fever, which was attributed by Dr. Charles B. Plowright, the medical officer of health, after most careful investigation, to the consumption of clams collected from "Vinegar Middle," which is situated on the marshes on the east bank of the Ouse about 2¾ miles from Lynn.

The cases occurred in the parish of North Lynn, and the notifications reached the medical officer of health as follows:—

May 24, 1900	... 1	Young adults.
June 2nd ,,	... 1	
,, 11th ,,	... 2	
,, 12th ,,	... 1	
,, 21st ,,	... 1	
		Ages.
,, 23rd ,,	... 1	14
July 4th ,,	... 1	10
,, 10th ,,	... 1	18
,, 11th ,,	... 1	6
	10	of which two were fatal.

These cases occurred in five houses situated on the salt marshes bordering the estuary of the Great Ouse. Drinking water was procured from three separate reservoirs some distance away, and milk was very little used.

All the ten cases involved had on two, if not three, occasions prior to their illness partaken more or less freely of clams.

An inspection of the 17 houses which comprise this part of North Lynn showed that the total population amounted to 70, and of this number 30 admitted having eaten clams during May and June; while the remaining 40 denied having done so.

Of the 30 consumers 15 ate the clams uncooked, and of these 10 had enteric fever; the remaining 15 had only cooked clams.

Illness in the first case commenced on May 17th, but the patient, although he consumed raw clams on two occasions shortly before his illness, was unable to remember the precise dates upon which he did so. His wife and family, who ate cooked clams, escaped.

The second case was taken ill on May 23rd, and the third on the 28th, both persons having eaten raw clams about 14 days previously. The two next cases were ill on the 2nd and 4th of June, and gave a similar history. Three apparently secondary cases followed in these houses a month later (viz., July 3rd, July 8th, and July 9th), but all three had partaken of raw clams at the same time as the initial cases.

Dr. Plowright further states that since the beginning of 1900, 40 cases of enteric fever were reported in the Freebridge Lynn Rural District, and of this number 16 occurred early in the year as an epidemic in the village of Castleacre. Of the remaining 24 no less than 15 gave a history of having eaten raw clams, and in 1 of having consumed the same shellfish cooked.

Other cases of enteric fever associated with clam eating were as follows:—

Three men living on North Wootton Marsh ate a number of cooked and uncooked clams during the latter part of March, and on the 15th and 31st of April two of these developed enteric fever, while the third, who had suffered from a severe attack of enteric fever in the previous year, escaped with gastro-enteritis.

In the same village a young married man who had consumed raw clams three weeks earlier was notified as suffering from enteric fever on July 11th, but his wife and child, who had no clams, escaped.

On July 15th a married woman living at the other end of the village ate three or four scalded clams, as also did three other members of the family, and on the 28th of July this woman developed enteric fever while the others escaped. Dr. Plowright observes that this is the only case in which enteric fever followed the eating of clams which had been even partially cooked.

On July 5th a young man at Castleacre, who two or three weeks previously had eaten raw clams, was notified as suffering from enteric fever, but in this case the source of the clams could not be ascertained.

Dr. Plowright states that clam-borne enteric fever was by no means confined to the rural district, since medical practitioners in the Borough of Lynn had about the same time several cases of it under their care.

It would appear, he concludes, that:—

(1.) The clam is a shellfish not infrequently consumed in large quantities in certain districts.

(2.) That uncooked it may, like other shellfish, be the means of conveying enteric fever.

(3.) That the shellfish on the Vinegar Middle and other sands at the mouth of the River Ouse are liable to sewage contamination.

TABLE TAKEN FROM DR. PLOWRIGHT'S REPORT.

Table of Enteric Fever Cases in North Lynn.

Family.	No.	No. who ate Clams.	Cooked.	Un-cooked.	Ate no Clams.	Enteric Cases.
E.B., Wife and Child ...	3	1	—	1	2	1
W.G., Wife and 5 Children	7	—	—	—	7	—
W.M. and 4 others ...	5	—	—	—	5	—
W.G. and Wife	2	—	—	—	2	—
G.G., Wife and 2 Children	4	4	—	4	—	3
W.E. and Wife	2	—	—	—	2	—
W.F., Wife and 2 Children	4	3	3	2	1	2
W.K., Wife and 1 Child ...	3	2	1	2	1	2
D.F., Wife and 1 Child ...	3	2	2	—	1	—
A.G. and 3 Children ...	5	—	—	—	5	—
W.M., Wife and Son ...	3	1	1	—	2	—
T.T., Wife and 7 Children	9	7	6	2	1	—
G.M., Wife and 2 Children	4	—	—	—	4	—
H.W.. Wife and 1 Child ...	3	3	3	3	—	2
J.G.W. and 1 Child ...	3	1	1	—	2	—
W.D.W. and 6 Children ...	8	6	6	1	2	—
C.W. and 1 Child	3	—	—	—	3	—
	71	30	23	15	40	10

Dr. Plowright points out that the set of the ebb after it leaves the mouth of the river is not straight down the channel between the stone banks but over towards the west side, while the "flood" comes in from the westward and over the east stone banks. Consequently any sewage in the channel will be taken over the east bank on to the Vinegar Middle Sand and on to the "Old Way," where the clams in question were collected.

With reference to the quality of the Lynn sewage, he points out that a large amount of work had in previous years been carried out in Lynn as regards the conversion of privies into water-closets, and that consequently the sewage of the town was more likely to contain the specific infection of enteric fever. He adds too, that during the spring of 1900, there were 22 cases of enteric fever treated in Lynn.

Dr. Plowright has been good enough, at my request, to go through his records for recent years, and he tells me that since 1900 he has had 90 cases of enteric fever in his district, and that exclusive of secondary cases arising from the first case, he can only discover five cases in which shellfish could be regarded "as the probable or possible source of the first case, and these were distributed in turn as follows: 1903, one case from cockles; 1904 (?), one case from mussels; 1907, two cases from clams (one cooked the other eaten raw); 1908, one case from clams."

The mussel case in 1904 had also eaten ice cream made in Lynn. Dr. Plowright tells me that he has been on the look out for possible shellfish cases ever since 1900, and therefore he would, he thinks, almost certainly have noted it if any suspicion had presented itself to his mind when he was investigating the causation of this malady.

The Sewage of Boston.

Boston itself has a population of over 16,000, and if the outlying district of Skirbeck be included, the total population hereabouts amounts to about 22,000.

Excrement disposal is almost entirely by privies, there being in Boston, Mr. Clarke, the Surveyor, informs me, not more than 1,000 water-closets, the number of which is, however, slowly increasing. Briefly stated, the drainage of Boston is discharged by a few main outfalls. On the east the greater portion of the drainage is taken by what is known as the Bar Ditch, which, curiously enough, discharges at the northern extremity of the town into the river, with the result that the whole of it has again to traverse the town. That portion of the eastern side of the town which does not discharge into the Bar Ditch discharges into the Bargate Drain, a fen drain which empties itself into the river a short distance seaward of the Boston Docks, and this Bargate Drain also takes the drainage from Skirbeck. Altogether this Bargate Drain takes the sewage of a population of about 2,000.

The Bargate Drain is for the most part cut off from the river by a sluice which is only opened on an average about once monthly, but in the event of heavy rain more frequent openings are necessary. Consequently this Bargate Drain hereabouts may not inaptly be likened to a relatively stagnant open cesspool diluted, however, by much surface water which, of course, at times may be great in amount. But the result is that when the sluice is opened there is poured into the river the accumulated drainage of parts of Boston and of Skirbeck, and the resulting discharge is, the Surveyor informs me, sometimes extremely offensive.

On the western side of the river there is one main outfall and numerous small ones, the main one discharging about 300 yards above the swing bridge.

The main sewers on both sides of the river are governed by valves which prevent the influx of river water into the sewers at high tide, and the usual practice is for the discharge of sewage to commence at about 1½ hours after the commencement of ebb, and closed about two hours before high water, and the effect of this procedure is that when the sewers are opened to liberate the sewage which has accumulated in the sewers during and near high water, there is about 15 feet of water in the river. The effect of this is that as the greatest velocity of the current is at and near half-ebb, and as the greatest in velocity is about four knots per hour, the main body of the sewage has opportunity of reaching the sea—under six miles distant—on each ebb, and consequently little or none of this maximum volume is brought back on the flowing tide. Near low water the depth of the channel varies from three to four feet, whereas at high water it may reach 27 feet—*i.e.*, there is a very large rise and fall of tide in this estuary.

The Sewage of Lynn.

The sewage of Lynn, with a population of about 20,000, discharges by four separate outfalls, each of which drains a population of about 5,000. In the case of three out of four of these outfalls the amount of fen drainage which discharges with the sewage is enormously in excess of the volume of sewage, and the circumstances are such that even when the sewage reaches the river it is already in a state of great dilution. The gates which govern these outfalls open, the Surveyor states, at about half ebb and close at or near half flood, which means of course that the sewage is held up for the last half of the flood and the first half of the ebb.

When the sewage enters the "Cut" on the ebb it is again enormously diluted, and it is only after a journey of some six miles that it can reach the mussel beds nearest to Lynn. Presumably by this time the mussel beds are exposed by the fall of the tide and consequently they are beyond the reach of the sewage brought down by the estuary and, as will be seen by the annexed chart, there are no mussel or cockle beds in or immediately alongside the channel.

Conversely on the flowing tide such diluted sewage as may have reached the Wash will have been so diluted before it can pass over the higher sandbanks that it can hardly be seriously considered as a danger, more especially as such sandbanks as are nearest Lynn are probably covered by water entering direct from the North Sea *via* the channels on the east of such sandbanks.

On the whole, therefore, it would not seem that the risk to which the existing mussel or cockle beds on this side of the Wash are exposed is at all great, but it would not in my view be desirable to gather shellfish any nearer to Lynn than is stated to be the case at the present moment (March, 1909).

"FEVER" IN BOSTON AND LYNN.

Boston (*Population* 16,621 in 1909).

Year.	Notifications.	Year.	Notifications.	Year.	Notifications.	Year.	Notifications.
1890 ...	0	1895 ...	17	1900 ...	43	1905 ...	26
1891 ...	9	1896 ...	11	1901 ...	27	1906 ...	22
1892 ...	3	1897 ...	28	1902 ...	17	1907 ...	14
1893 ...	97	1898 ...	34	1903 ...	23	1908 ...	14
1894 ...	4	1899 ...	34	1904 ...	23	1909 ...	12
Lynn (*Population* 21,584 in 1909).							
1890 ...	10	1895 ...	27	1900 ...	59	1905 ...	20
1891 ...	13	1896 ...	26	1901 ...	49	1906 ...	21
1892 ...	131	1897 ...	494	1902 ...	40	1907 ...	23
1893 ...	50	1898 ...	150	1903 ...	47	1908 ...	31
1894 ...	34	1899 ...	108	1904 ...	47	1909 ...	3

THE BRANCASTER MUSSEL AND COCKLE "LAYINGS."
(Map No. 10.)

These "lays" or "layings" are to be found over a large part of Brancaster Harbour and the creeks which empty themselves therein.

On the west a considerable portion of Mow Creek is, at times, occupied by cockle lays, while the mussel lays, commencing opposite what is known as Staithe House, extend at intervals (as shown on map No. 10) up the main channel and up Norton Creek to the eastward for a mile or more.

In so far as the main Brancaster Channel is concerned, the lays extend seawards for about half-a-mile beyond the junction of that channel with Norton Creek. Over most of the area referred to the channel is let out to the fishermen by the lord of the manor in strips of about 50 yards wide. The rents of the strips vary from 1*s.* to £1 per annum, according to the size, and the total rent obtained by this owner is £20. There are some 50 lay holders at Brancaster.

The mussel brood is obtained either from the public beds in the Wash or from the grounds of the L'Estrange Fisheries, which are now let to a shellfish merchant who utilises part for oyster culture and who underlets part for mussel and cockle culture.

Brood, when scarce in the Wash, is procured from other places along the East Coast, but, from whatever source obtained, it is deposited in the first instance alongside the layings, and as it becomes of sufficient size it is placed on the layings themselves.

When required for market the mussels are brought up to the nearest quay or "hard," and, if not immediately required, they may sometimes be stored in the old oyster pits or ponds, of which some still remain. These ponds have, generally speaking, brick or gravel bottoms, but in some instances along this part of the Norfolk coast cement has been employed. The sides are lined with wood, and through one of such sides is a small channel or canal through which the water when the tide is sufficiently high may be admitted or, when the tide has ebbed, be liberated.

The level of these ponds is such that they are only covered with water at or near spring tides. Occasionally oysters are laid down in Norton Creek or elsewhere, and at the time of one of my visits some 30,000 oysters were deposited there. The shellfish from this area are, Dr. Sumpter informs me, despatched from Burnham Market Station to Norwich and Lowestoft, Leicester, Yarmouth and Stowmarket, but some are used along the coast as bait by the long-line fishermen.

There are, Mr. Morris, the sanitary inspector, states, at Brancaster and Brancaster Staithe, about 70 fishermen engaged in the shellfish industry, and he estimates that at least from 200-300 people, including women and children, are mainly dependent for a livelihood on this industry.

Risks of Contamination.

As regards opportunities for specific infection of the shellfish hereabouts it may be said that they are small.

For some time there were two house drains discharging dangerously near to the mussel "lays." One of these drains was from Staithe House, the other from Marsh House, but both of them have been cut off through the praiseworthy action of the inhabitants and the local sanitary authority.

Such pollution as may possibly threaten these beds very remotely is from a sewer about half a mile long which discharges untreated slop water into the head of Mow Creek. This sewer is stated to take the slop water from some 30-40 houses, seven of which are provided with water-closets, the daily flow from the sewer being estimated at from 1,200 to 1,500 gallons. But this sewer discharges its contents so high up the creek that they remain stagnant upon the mud in the vicinity of the outfall until the high water of spring tides carries them over the marshes in a state of enormous dilution.

Under all these circumstances the risk to the cockles laid down nearly a mile away is but slight. But, this notwithstanding, it would be a wise measure if the sewer in question could be led elsewhere or other means adopted for the disposal of the local slop water.

It has, too, to be recorded that specimens of mussels and water were taken from the entrance of Mow Creek upwards some two or three years ago and submitted to Dr. Andrewes, of St. Bartholomew's Hospital, for bacteriological examination. In his view neither showed any signs of pollution.

OVERY STAITHE MUSSEL AND COCKLE "LAYS."

(Map No. 10.)

The shellfish industry at Overy Staithe is not very extensive at the present day, although the old oyster pits on the foreshore bear witness to the brisk trade of years gone by.

There are now not more than 12 persons engaged in the industry and the lay holders pay only 5*s.* rental per "lay."

The "layings" extend at intervals up Overy Staithe and into Burnham Harbour; and mussels are sometimes laid down for a short distance to the west of the island opposite the quay, near the "sand" in Overy Creek to the north-east of Overy Marsh, and also to the south of the Gun Hill.

There is, the sanitary inspector informs me, but one small drain and this discharges a short distance to the west of the coastguard station. These shellfish, like those from Brancaster, are said to go to Norwich and Lowestoft, and to Midland towns. Some are utilised for bait.

Epidemiological Evidence.

No instances of alleged enteric fever from the consumption of shellfish collected either from Brancaster or Overy Staithe have been brought to my notice. Dr. Sumpter, the present medical officer of health of the Docking Rural District and of New Hunstanton Urban District, has not been able to attribute any cases of enteric fever to shellfish.

A case of a tramp who apparently ate mussels and clams collected at some 100 and 150 yards respectively from the Hunstanton outfall, and who subsequently developed enteric fever, was brought to Dr. Sumpter's notice, but it would seem that she may have, also about this time, consumed shellfish taken from a polluted area elsewhere, and the evidence must be regarded as quite inconclusive. Dr. Sumpter had shellfish from the places from which they were alleged to have been taken by the tramp examined by competent bacteriologists, and they were pronounced quite unpolluted.

THE WELLS MUSSEL INDUSTRY.

There are numerous mussel "lays" at Wells Harbour, extending in front of the quay and up the channel which runs eastward thereof, the whole area covered being not far short of a mile in length.

The industry is an important one, and there were in March, 1909, some 55 lays worked by 25 lay holders. Mr. Donnison estimates that there may be some 80 persons mainly dependent on the industry, a figure doubtless including the families of the lay holders, an estimate with which, thus interpreted, Dr. Calthrop, the medical officer of health, agrees. The mussel lays are divided locally into three groups, the best from the point of view of the mussel merchants being those in the quay opposite Staithes Street.

The actual owners of the foreshore upon which the lays are situated are the Wells Harbour Commissioners, who exercise jurisdiction under powers confirmed by the Wells Harbour Acts, 1835 and 1844, over the whole of the foreshore. The lays are leased for periods of three years, one year's rent being paid in advance. The last annual rental received amounted to about £58.

The lays at low water present the appearance of land let out in allotments, and the lay holders may be seen at that time walking over their holdings cleansing the mussels, and generally tending their stock.

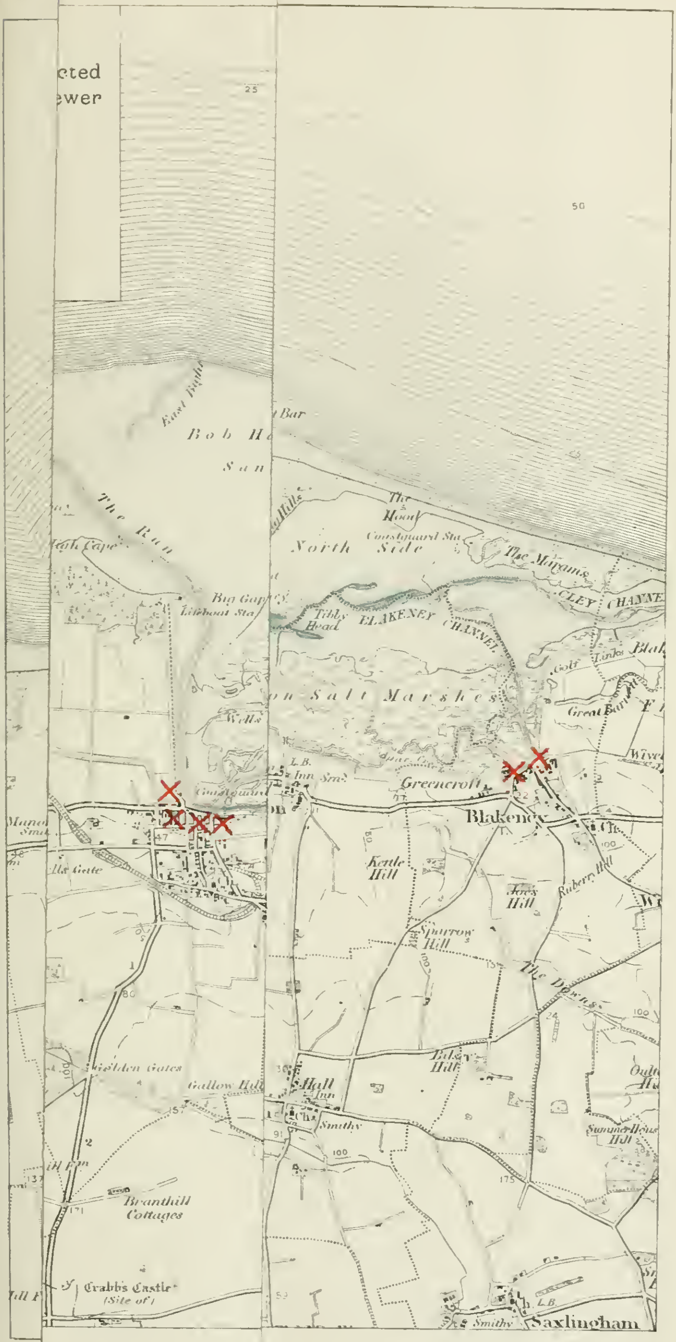
The brood mussels which are obtained from the Wash or elsewhere are allowed to remain upon their lays until they are large enough for market, when they are brought higher up the foreshore for purposes of accessibility and cleansing, each lot of mussels being surrounded by a cable with a view of enabling the fishermen to identify their stock and to prevent them from being displaced by tide or storm.

When ordered the mussels are cleansed, packed and despatched. The chief destinations of these Wells mussels were Norwich and Lowestoft, but recent events, to be referred to shortly, have considerably curtailed the sale of these mussels and it is very difficult to ascertain to what places they go. It is said that a very large quantity are now consumed in Wells. Some, too, are, at times, used for bait.

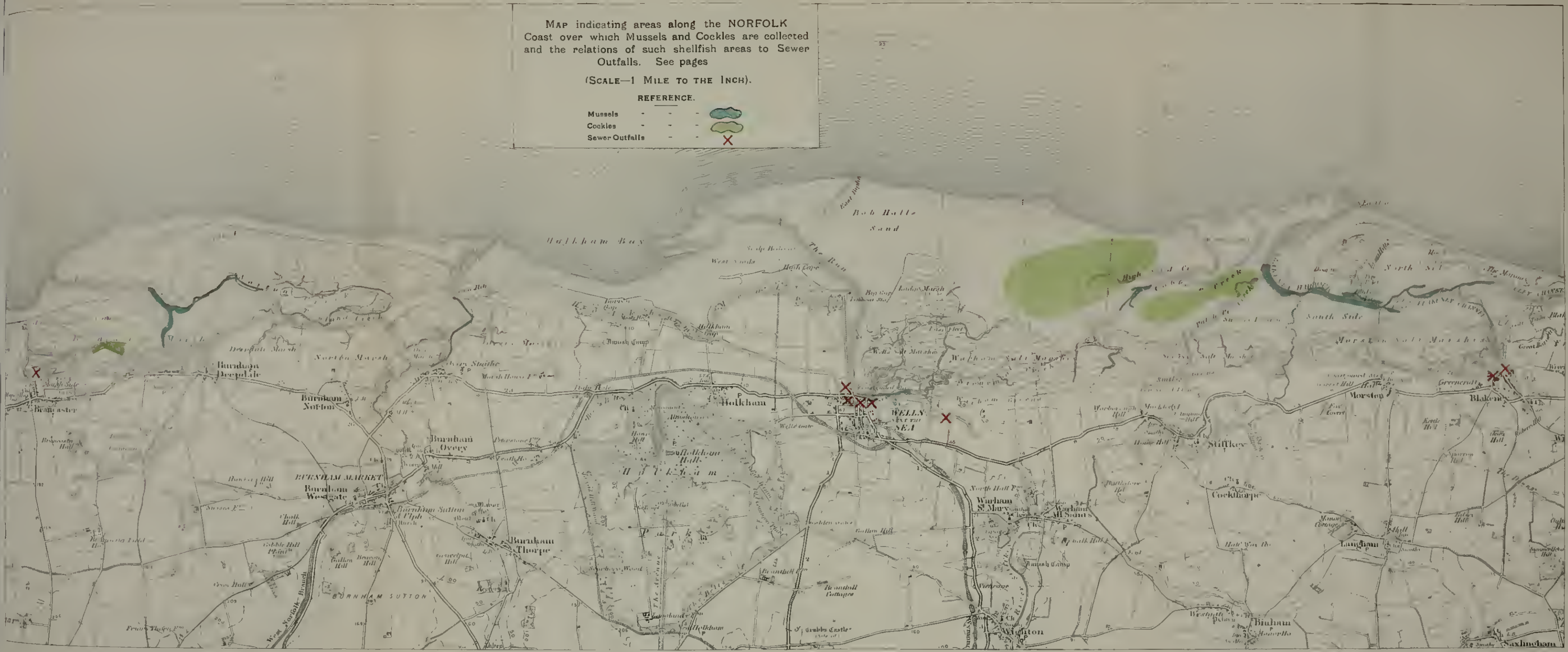
Facilities for the Contamination of the Wells Mussels.

The slop water of Wells (population about 2,000) enters Wells Harbour in what may be described as three more or less distinct

MAP No 10



Ordnance Survey, Southampton, 1910.



[illegible] Southampton [illegible]

divisions, a circumstance which is due for the most part to the different levels of the town.

The total number of houses is 615, and at my request the sanitary inspector, Mr. Richford, has computed the number of houses drained in each direction. About 220 houses drain to the east of the town by means of an 18-inch pipe which enters a ditch near the church. The contents of this ditch, after a circuitous route over the marshes for close upon a mile, enter Stonemead Creek through a sluice. There is no doubt that considerable subsidence takes place in the ditch, but such of the drainage as remains in solution or suspension must pass, in a state no doubt of considerable dilution, over the mussel layings in Stonemead Creek and in the harbour proper, and this condition of affairs would certainly be greatest at periods of heavy rainfall. What may be termed the second portion of the sewage, which takes the drainage from 172 houses, discharges by about a dozen separate outfalls directly into the harbour and thus immediately over the mussel lays in this position. The third portion, draining some 220 houses, discharges into a dyke to the west of the town and, with the contents of such dyke, enters the "Run" through the near sluice.

It will therefore be seen that, with the exception of the latter portion, all the slop water of Wells passes over the mussel lays. It is clear, too, since the new sluice is open during the first part of the flood, that some of the slop water from this source may also be carried over the lays. It is no doubt true that at and near high water the dilution by the tide is so great that, relatively to the total bulk of water, the slop water is then almost negligible, but it is equally true that at and near low water many of the lays in Stonemead Creek are actually uncovered, while over the lays opposite the quay there is but very little water. Consequently, such slop water as is then discharged from the drains may reach the mussels in a state of but slight dilution.

But this is by no means all. The custom of storing the mussels on the foreshore for purposes of accessibility and convenience is, under the circumstances which have obtained for years and which also obtained in March, 1909, fraught not only with the danger of specifically polluting the mussels, but with the by no means improbable fouling of the mussels with slop water and other garbage.

Enteric Fever in Wells.

The following table represents the notifications of enteric fever in Wells for each of the years 1894 to 1909:—

Year.	Cases.	Year.	Cases.
1894	2	1902	0
1895	0	1903	1
1896	0	1904	0
1897	0	1905	0
1898	1	1906	0
1899	0	1907	0
1900	0	1908	12
1901	0	1909	0

It will be seen that cases have been relatively rare until the year 1908, when there were 12 cases notified between June and September. The cause of these cases is unfortunately by no means clear, and I understand that all the patients deny having eaten mussels prior to attack. In so far as the drainage system of Wells is concerned, about one-fifth of the attacks occurred on each of the three areas above referred to.

Epidemiological Evidence in connection with Mussels from Wells.

Dr. Cooper-Pattin, the medical officer of health of Norwich, ascribed an outbreak of enteric fever which occurred in that city in August and September, 1908, to the consumption of mussels from Wells, and he states that the interdiction of the Wells mussels both by public notice and by actual destruction was followed by rapid decline in the number of cases.

It has to be noted that there was enteric fever in Wells from June to September, 1908, and under the circumstances and conditions already described it is clear that Wells mussels may have been specifically polluted at Wells.

As a consequence of the enteric fever at Wells and Norwich, and as the result of certain letters by Dr. Cooper-Pattin, Dr. Nash, and Dr. Calthrop, coupled with the results of bacteriological* examination of the mussels, the sale of Wells mussels was, on the advice of Dr. Calthrop, prohibited by the urban district council.

The clerk to the district council warned all the lay holders by public notice that "heavy fines or imprisonment may be in- "flicted upon persons offering or selling any shellfish which may "be proved unwholesome or unfit for the food of man." Apparently this action was taken during the first week in September, 1908.

But early in January, 1909, it was resolved, without the knowledge of the medical officer of health, to rescind the notice and, in so far as the district council was concerned, there was no obstacle to the sale or despatch for sale to other places of mussels gathered in the vicinity of one or another of the sewer outfalls. But I am informed by Dr. Calthrop, that in April, 1909, the urban district council caused to be circulated yet another notice drawing attention to the penalties incurred by the sale of polluted shellfish.

In my view either the sale of Wells mussels for human food should be entirely prohibited or the whole of the slop water of

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* One of the samples for bacteriological examination was taken from opposite the quay (*i.e.*, near the sewer outfall) and the other midway between the eastern sluice and Ship Cottage; that is to say, as far as practicable from the quay sewer outfalls.

The first sample was regarded by the bacteriologist as undoubtedly polluted by sewage and the second as polluted to half the extent of the first.

Dr. Cooper-Pattin submitted the Wells mussels to another bacteriologist, and he also regarded them as polluted.

Wells should be intercepted and carried well away from the town and in such a position and manner as to render its return to the harbour impracticable.

THE STIFFKEY COCKLES AND MUSSELS. (Map No. 10.)

The Stiffkey or "Stewkey" cockles, as they are called, have had a reputation from time immemorial. At present there are some 20-30 women engaged in the cockle industry here and other gatherers come from neighbouring parts to collect cockles over the expanse of sand beyond the Stiffkey Marshes (see map No. 10). The cockles are gathered in baskets by means of hooks or bent knives, washed in the sands, packed in bags, and carried across the marshes to the foot of the roadway which leads down from Stiffkey to the marshes. Here the carts of the cockle hawkers await them and the cockles, after being measured, are emptied then into the carts. Some of the larger cockles are, however, kept separate and sold at a higher price.

The labour of collecting the cockles is an arduous one owing to the distances which the women—clad in a special and peculiar dress—have to walk to reach the cockle sands and to the return journey when laden with the bags of cockles. The women earn, I am told, no more than about 1*s.* to 1*s.* 3*d.* a day. The cockles are hawked about the neighbouring parts of Norfolk for long distances but none are despatched by train to any of the large towns.

Clams are also collected hereabouts and sold for 6*d.* a score. These molluscs make excellent soup and they are largely utilised for this purpose in the United States of America.

There are also some mussel lays in Cabbage and neighbouring creeks, the mussels when ready for market being brought to a creek near to the road where the cockle carts await the gatherers.

Both the cockle and mussel beds hereabouts are far removed from any source of pollution, a fact that will be at once apparent by a glance at map No. 10.

THE BLAKENEY MUSSEL "LAYS." (Map No. 10.)

These lays are numerous and they extend over a considerable area of both Blakeney Harbour and Cley Channel. They extend in fact from near the lifeboat station seawards, and up Blakeney Harbour and Cley Channels, a distance of over two miles. It is at intervals over this area that brood mussels are laid down, and when they are ready for market it is the custom to transfer them up the channel near to the village of Blakeney. Here the mussels are stored on the foreshore in a manner similar to that described in connection with Wells. I was told by the coastguard at Morston in March, 1909, that some 30 men possess lays in this locality, and Mr. Donnison estimates the number of persons more or less dependent upon the industry at 80. The slop water of Blakeney enters the Blakeney Channel at the quay by means of two separate outfalls, one to the east and the other to the west of the quay. That to the east takes the slop water from the High Street, which comprises, the sanitary inspector tells us, about 200 houses, that to the west takes the slop water from about 20.

The mussel lays are fully two miles from the nearest outfall, and the amount of slop water being small the risk to the mussels in the lays is remote. But it is otherwise with the mussels which are stored on the foreshore near to Blakeney village, which are, some of them, at a distance from the main outfall which affords them opportunities for pollution by slop water. On March 11th, 1909, I saw mussels stored on the foreshore within 60 yards of the main outfall, and there were numerous other heaps on the foreshore at distances which would in no sense ensure freedom from pollution.

As has already been said, these mussels are brought from the lays for the purpose of accessibility to market, and it must be said that, having regard to the proximity of the sewers, the practice is to be deplored as it is one which is likely to prejudice the public against the mussels of the locality generally.

Epidemiological Evidence as to Stiffkey and Blakeney Shellfish.

Dr. W. H. Fisher, medical officer of health of the Walsingham Rural District, reports that he has not been able to trace any case of enteric fever in this district to the consumption of shellfish.

Mussels and cockles are, he states, partaken of in all the villages of the district, the hawkers passing through once and sometimes twice weekly. He adds, however, that cases of gastro-enteritis are frequently seen after a free meal of mussels.

THE RIVER YARE MUSSEL BEDS. (Map No. 11.)

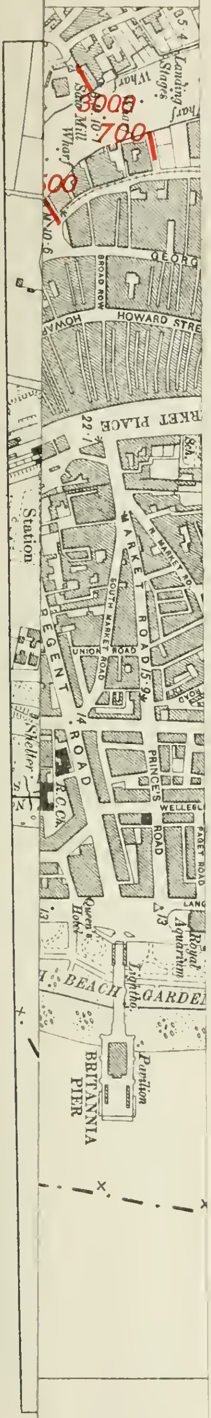
Attention has for the last ten years been called to the mussels in the Yare as a source of enteric fever in Yarmouth as well as in Norwich. The mussels may be dredged for practically over the whole length of the Yare from Breydon Water to its mouth, but at the present time I am told that the dredgers affect certain portions more particularly, *i.e.*, Breydon Flats and areas in the neighbourhood of Vauxhall Bridge, the Town Hall and Trinity Wharf.

The dredges used are identical with those employed in oyster dredging, and the mussels when collected are used partly for bait and partly for human food.

There is not now, the medical officer of health thinks, much dredging for mussels in the harbour, but as will be seen directly there is great difficulty in putting an end to it altogether.

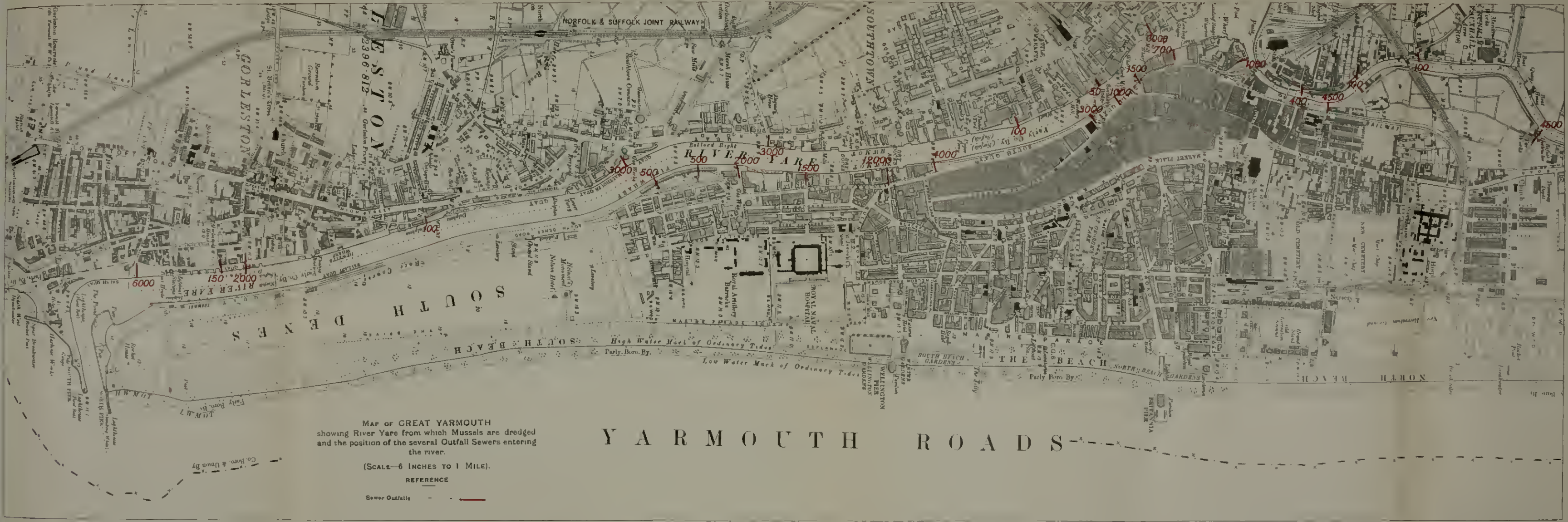
Sources of Contamination.

The accompanying map (No. 11), which was prepared for me by Mr. Cockrill, M. Inst. C.E., the Borough Surveyor, shows in itself the obvious dangers to which the mussels in this river must



Landing Stages
Wharf
Saw Mill
Wharf
3000
700
500
GEORGE
BROAD ROW
HOWARD STREET
MARKET PLACE
Sch.
Station
MARKET ROAD
N. MARKET ROAD
SOUTH MARKET ROAD
UNION ROAD
REGENT ROAD
PRINCE'S ROAD
WELLESLEY
PAGET ROAD
R.C.Ch.
Shelter
Queen's Hotel
Royal Aquarium
BEACH GARDENS
Lightho.
Pavilion
BRITANNIA PIER

MAP No. 11



Map of GREAT YARMOUTH
showing River Yare from which Mussels are dredged
and the position of the several Outfall Sewers entering
the river.

(Scale—6 Inches to 1 Mile).

REFERENCE

Sewer Outfalls - - ―

Ordnance Survey, Southampton 1910

be subjected. It will be seen that there are no fewer than 25 separate sewer outfalls entering the river as it traverses Yarmouth, and in connection with each outfall the population draining thereto are marked. All the sewage entering the harbour does so in an untreated condition, although owing to the arrangements made for flushing the sewers with sea-water, material dilution takes place at times. So far as is practicable the sewage is liberated into the river at the beginning of ebb, and although six of the sewers are provided with emergency pumps, these are only used on the ebb except when the tide is unduly held up.

The surveyor states, too, that taken throughout the year, three-fourths of the sewage is discharged under such conditions as will carry it out to sea before the ebb turns. The mussel beds are always covered with water so that the sewage is much diluted before it reaches the mussels. But, notwithstanding all these facts, there can be no question that the mussels in the harbour are exposed to the risks of specific contamination.

Epidemiological Evidence.

In his annual report for 1899, Dr. Bately, the then medical officer of health, attributed an uncertain amount of enteric fever to the consumption of mussels, and he was evidently inclined to regard the smaller number of cases of enteric fever which were notified in that year to the warning notices which had been issued relative to the danger of consuming the Yare shellfish. He also observed: "It is interesting to note a considerable reduction in "typhoid notifications last year in Norwich. The suppression "of mussel dredging in Yarmouth has most probably had a "wider influence for good than is generally recognised."

But in the following year when there were 123 cases of enteric fever, Dr. Russell, the successor of Dr. Bately, thought that shellfish as a cause could be practically eliminated, since enquiries made at the patients' houses showed that in not one instance had shellfish been recently consumed.

In 1901 no reference is made to shellfish, and in 1902 Dr. Russell ascribes decline of enteric fever to "the various sanitary "improvements" carried out in recent years.

In 1903, Dr. Beach, the present medical officer of health, states that four cases out of a total 28 illustrate the risk run by eating mussels dredged from the river, and in 1904, 10 cases out of 64 may have been infected from shellfish which in some instances had, it is stated, been exposed to pollution. Out of the 10 cases, four are definitely stated to have eaten mussels, and in the annual report for this year, Dr. Beach regards the diminution of enteric fever in the borough as largely due to the notices exhibited by Dr. Bateley's advice. In 1905, nine cases out of 38 gave a history of the consumption of mussels at dates corresponding with the incubation period of the disease and, it is added, "there can be no doubt as to the source of the infection."

In 1906, 17 out of 45 cases were attributed to mussels, and Dr. Beach observes that "although warning notices have been posted

" about the town nothing short of the total prohibition of dredg- " ing for mussels in the Haven and in Breydon will be of any " effect. At present dredging is permitted for bait only, but " there can be no doubt that some of the 'bait' finds its way " into the hawkers' baskets with disastrous results to those who " are not immune to the effects of eating food befouled with " sewage." In 1907, 12 cases out of 37 may have been due to shellfish.

In March and April, 1908, cases of enteric fever occurred in Norwich, which the medical officer of health found to be associated with the consumption of mussels procured, it was alleged, from Breydon Water at Yarmouth.

It is stated, that on issuing notices cautioning the public as to the danger and, a little later, destroying the suspected mussels, the prevalence of enteric fever at once declined. The events in question are tabulated below.

Table showing number of cases of Enteric and Continued Fever notified year by year in Yarmouth and the proportion attributed to shellfish.

Year.	Notifications.	Year.	Notifications.	Cases attributed to Shellfish.
1890	299	1900	130	—
1891	143	1901	87	—
1892	103	1902	38	—
1893	174	1903	28	4
1894	103	1904	64	10
1895	187	1905	38	9
1896	143	1906	45	17
1897	150	1907	37	12
1898	289	1908	35	8
1899	141	1909	35	0

THE COCKLE BEDS OF THE ORWELL ESTUARY.

(Map No. 12.)

The estuary of the Orwell (see map No. 12, annexed) extends from Ipswich to near Harwich, where, after joining with the estuary of the Stour, it empties itself into the sea between Dovercourt and Felixstowe. At high water, the Orwell, viewed from the elevated land on either side presents a broad expanse of lake-like water, but at and near low tide extensive mud flats are exposed on both sides of the main channel and the water area is materially curtailed. There is, however, always a considerable volume and depth of water in the channel.

It is over the mud flats which extend from Ipswich to Pin Mill (about six miles) that cockles are collected and, as will be seen later, they are chiefly gathered in the vicinity of the Ipswich main outfall.

The Extent of the Cockle Gathering.

In years gone by, there was, I understand, a definite industry in Ipswich cockles, and even now it appears that at times a few cockles may be despatched to certain East Anglian towns.

But I am assured both by Mr. Bantoft, the Town Clerk, and by the medical officer of health, that at the present time the cockle gathering is of an intermittent and casual character indulged in by persons who desire some of these molluscs for their own use or whose practice it is to hawk them from door to door in the poorer parts of the town. As Dr. Pringle, the medical officer of health, informs me: "it may be definitely stated that "there is no evidence that these cockles are collected as a definite "trade on the part of anyone. Such was the case a few years "ago but it is not so now." Dr. Pringle adds that he regrets his inability to verify a statement that Ipswich cockles have recently been the source of enteric fever in other towns.

Whatever may have been the facts in the past, it is clear, I think, that at the present time no fees are paid for permission to collect cockles and that no one claims any proprietary right in these molluscs. The foreshore of the estuary is vested by Charter in the Corporation of Ipswich, and the Town Clerk informs me that no jurisdiction has ever been exercised over the cockles in the estuary.

The Pollution of the Orwell by the Sewage of Ipswich.

The borough of Ipswich, which has a population of about 75,000, is at the present time almost entirely drained by means of water-closets, there having been a great diminution in the number of privies which formerly obtained, during the last 12 years.

The town is sewered on the combined system, practically the whole of the sewage being discharged at a point on the eastern side of the estuary about 1½ miles from the centre of the town (see red cross on 1-inch map). The sewage is subjected to no further treatment than it obtains from coarse screening and by temporary subsidence in settling tanks, the supernatant fluid or effluent being discharged into Fen Bight, when the tide has so far ebbed as to enable this to be done effectually. In addition to the main sewer outfall there are some 14 storm overflows which discharge at certain points into the River Gipping and into the docks and the estuary in the neighbourhood of the town.

The effect of this method of discharge at the main outfall is that a considerable portion of the sewage is carried up above the outfall by each flowing tide, and it thus comes about that in the neighbourhood of the outfall there is what is known as a "sewage zone," *i.e.*, a portion of the estuary which is practically always polluted by sewage. It is obvious that consequently the greatest pollution of the foreshore is in the neighbourhood of the outfall, and it is hereabouts that the greatest number of cockles are collected. As the medical officer of health states in a report made to me upon the subject, "the best and fattest cockles are "found round the sewer outfall and in the reaches of the river "above, and it has been conclusively proved that these are the "cockles collected and used for food in the town." Although cockles are in some degree collected from many parts of the estuary, Dr. Pringle observes that there is no evidence that the cockles grown below (*i.e.*, seaward of) Pin Mill are associated with danger.

Epidemiological Evidence relative to Ipswich Cockles as a factor in causation of Enteric Fever at Ipswich.

Up to the year 1902 no suspicion appears to have attached to Orwell cockles in connection with the extensive prevalence of enteric fever in Ipswich. The main causative factor was thought to be the conservancy system of excrement disposal which then obtained.

But in his annual report for the year 1902, Dr. G. S. Elliston, at that time medical officer of health, stated that in June of that year it became apparent that cockles collected from the upper reaches of the estuary were causing enteric fever in the town, and consequently handbills were issued warning the inhabitants of the danger which they incurred in eating cockles collected from the Orwell.

It will perhaps be well to quote from Dr. Elliston's annual report for 1902. He says:—

"Typhoid fever was present in Ipswich all through the winter, "sporadic cases cropping up in opposite quarters, but it was not "until June that it commenced to increase. All the cases were "carefully investigated at the time and several in the outlying "districts were put down to defective drainage and the usual "soil pollution from foul midden pits. Towards the end of June, "however, out of 10 cases of typhoid fever notified there was a "distinct history of six having eaten shellfish from the River "Orwell, which on further investigation turned out to be "cockles. During the month of July 39 fresh cases of typhoid "fever were notified, nine of these admitted to having eaten "cockles a fortnight or three weeks before the illness, two to "oysters and two apparently contracted the illness through acci-"dentally swallowing river water. The cockles cases occurred "during the early part of the month, and doubtless there would "have been many more had not the Health Committee by adver-"tisement and distribution of handbills warned the public that "they were sewage polluted and unfit for food."

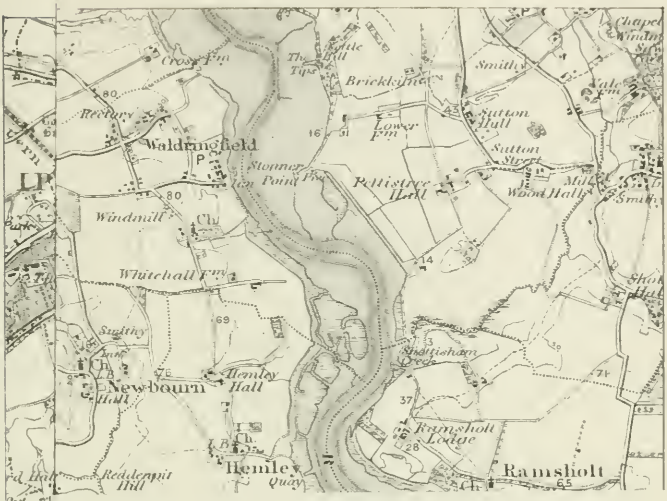
Twelve of these cases of enteric fever which occurred during this same month were attributed to the flooding of the street sewers, and Dr. Elliston tabulates the enteric fever in Ipswich during 1902 as follows:—

Notifications.	Sanitary defects and doubtful.	Cockles.	Oysters.	River Water.	Flood.	Imported.
173	104	35	6	11	12	5

and he adds that these figures indicate what a potent factor cockles were in the prevalence of enteric fever during the summer of 1902.

He refers to a group of four cases:—A man, his son, a married daughter and her husband developed enteric fever under circumstances which exonerated water, milk and insanitary defects, and

MAP No. 12.


Cross Fm
The Tips
Kettle Hall
Brickkilns
Smithy
Chapel
Windmill
Vale Fm
Sutton Hall
Sutton Street
Rectory
Waldringfield
P
Stonner Point Fm
Inn
Lower Fm
Pettistree Hall
Mill
Wood Hall
Smithy
Windmill
Ch
Whitchall Fm
Smithy
Inn
Ch
L.B.
Newbourn
Hall
Hemley Hall
L.B.
Ch.
Hemley
Quay
Reddenpit Hill
Shottisham Creek
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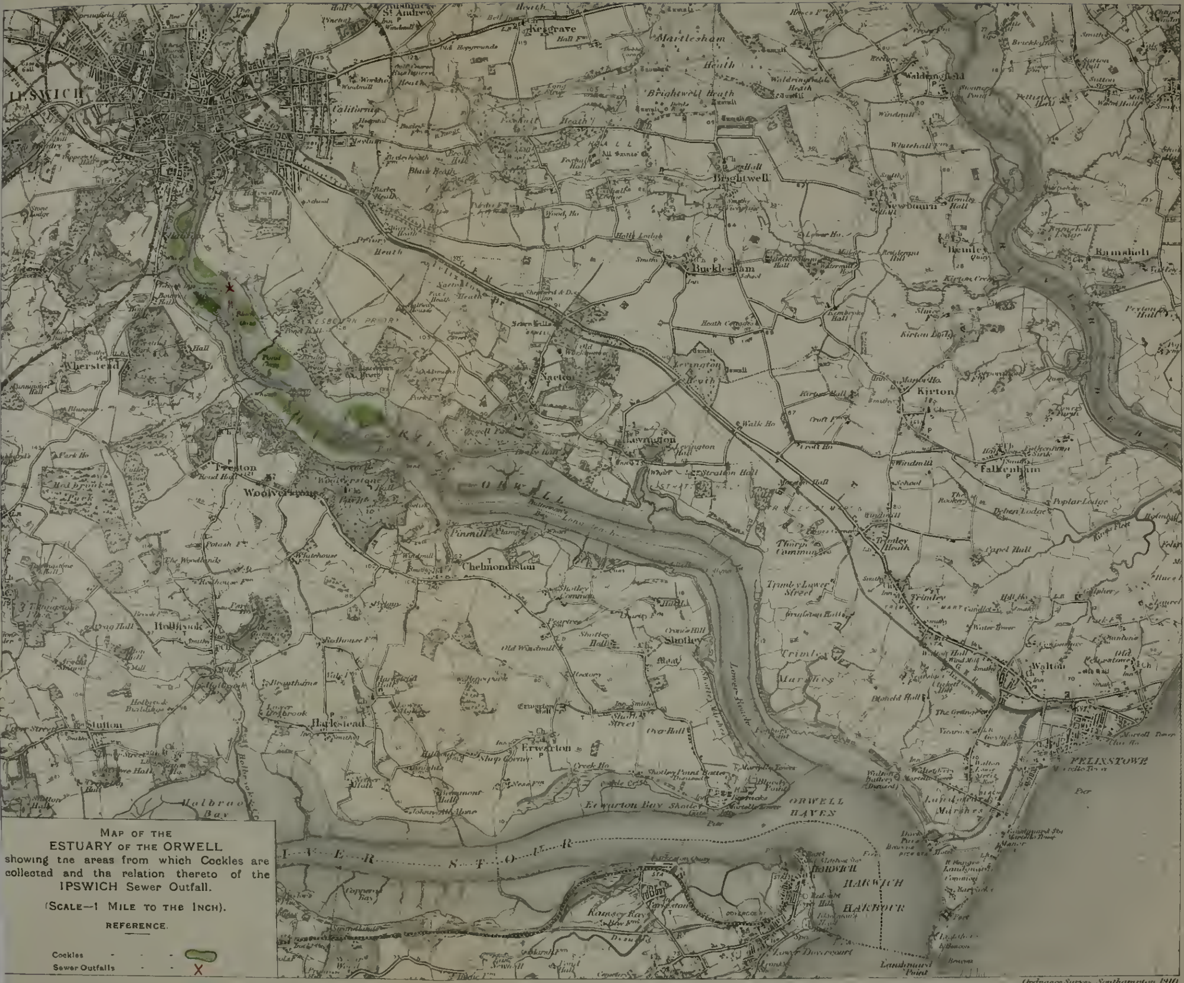
MAP No. 12.



MAP OF THE
ESTUARY OF THE ORWELL
showing the areas from which Cockles are collected and the relation thereto of the IPSWICH Sewer Outfall.

(SCALE—1 MILE TO THE INCH).

REFERENCE.

Cockles - - - 🟩

Sewer Outfalls - - ✕

Ordnance Survey, Southampton 1910.

in which the father admitted that about a fortnight previously he had had a basket full of cockles collected from the Orwell, near the bathing place. Of this family the son died, the father had a severe complicated attack from which he eventually recovered and the other two suffered an attack of average severity.

On July 9th a sample of cockles was taken for bacteriological examination, but although B. coli were found, the analyst was unable to state that the cockles were polluted with sewage.

But in September of the same year, samples of cockles taken from (a) between Hog Highland at the sewage outfall and (b) from near the bathing place, were bacteriologically examined. The analyst was unable to find the bacillus of enteric fever in (a), but in (b) an organism was found which was "identical with "B. typhosus." The analyst inferred that the cockles were both potentially and actually capable of conveying enteric fever.

In 1903, out of 45 cases notified Dr. Elliston attributed five to eating partially cooked cockles from the River Orwell. "The "other cases were either imported from other districts or were "sporadic ones without any apparent cause including five very "doubtful attacks of simple fever."

The Sanitary Committee again placarded the district and employed men to collect cockles for destruction. Between the beginning of May and the middle of August cockles were collected daily, during which time 791 bushels were paid for and destroyed. Dr. Elliston, while admitting that it may be but a coincidence, adds that during this period no case of typhoid fever in the town was traced to cockles, and only five cases of typhoid fever directly due to eating partially cooked cockles occurred between September and December.

In his annual report for 1904, the medical officer of health observes:—

"There were only one or two cases (of enteric fever) due to "eating cockles from the river mud. Printed notices were again "issued warning the public of the risk of eating cockles from the "mud bank of the upper reaches of the river, and it was also "intimated that proceedings would be taken against dealers ex- "posing such shellfish for sale. All these precautions appear to "have been attended with the best results as towards the end of "the year typhoid fever had almost died out in the borough."

During the summer of 1905—

"There were three distinct outbreaks of typhoid fever traced "to eating cockles, the most serious one occurring in August "when nine persons were simultaneously attacked with this "fever. The cause of the illness was probably due to some im- "perfectly cooked cockles which they all ate at a supper given "by a neighbour. The cockles were proved to be gathered from "the mud banks of the upper reaches of the River Orwell, and "printed notices were again issued warning the public of the risk "of eating them. These handbills together with a notice in the "public press evidently had a good effect, for no more cases of "typhoid fever traceable to river cockles occurred during the "last three months of the year."

The above is taken from the last report of Dr. Elliston, the annual report for 1906 being written by Dr. Pringle, the present medical officer of health, who makes the following observations relative to enteric fever:—

"Enteric fever is essentially a filth disease, and its prevalence "is in some degree an index of the general sanitary condition of "the town. Twelve years ago there were at least 8,000 privy "middens in the borough; to-day there are less than 80. Thus "the borough has been converted from a privy-midden town into "a practically entirely water carriage.

"It is not surprising, therefore, that in the last four years the "prevalence of enteric fever should have been consistently low; "the number of notifications having been 45, 50, 50 and 36.

"Enteric fever in Ipswich is, however, not a mere matter of "filth conditions. It is complicated by the influence of cockles "taken from the sewage polluted zone of the River Orwell and "sold for consumption in the town.

"It is known that cockles are capable of containing the or-"ganism which causes enteric fever, and that when such cockles "are eaten the disease may be acquired by the individual con-"suming them. It is known that certain of the cockle beds in "the River Orwell are within the sewage zone of the river, and "it has been proved definitely that these cockles are contami-"nated with sewage. It has further been proved in a previous "epidemic that some of the cockles contained the organism of "enteric fever. It is, therefore, abundantly clear that the con-"sumption of cockles taken from the River Orwell is a procedure "fraught with grave risk of an attack of enteric fever. Last "year posters were issued and displayed in conspicuous positions "in the town warning the public of the danger of eating cockles "taken from the Orwell.

"In spite of this fact seven cases were admitted to hospital, "in which the history of the cases pointed strongly to the pre-"sumption that the infection had been derived from cockles."

In 1907 out of 29 cases contracted in the borough nine were traced to the consumption of cockles taken from the River Orwell, the whole of these cases having occurred about the same time, *i.e.*, from the middle of June to the end of the first week in July.

Dr. Pringle adds:—

"As considerable doubt has been expressed as to the capacity "of the cockles for spreading enteric fever, the following case "is quoted as the proof is as nearly absolute as possible.

"A family of six people partook of a meal of cockles with one "exception, a child of six years. This child remained quite "well during the whole of the subsequent period. Of the five "who partook of the cockles one was taken violently the next "day with an attack of diarrhœa and vomiting, from which "complete recovery ensued in a few days. Some three weeks "afterwards two of the family were notified as suffering from "enteric fever, and were at once removed to hospital.

"In both cases Widal's reaction was present in a typical "degree. As a result of inquiries the blood was taken from the "other inmates of the house and tested. It was then found that "two other members of the family gave a typical reaction, and "they were accordingly removed to hospital. All the four individuals taken to hospital passed through typical attacks of "enteric fever.

"The two who did not give the reaction were the child already "mentioned and the one who had had the attack of vomiting "and diarrhœa the day after eating the cockles.

"At the same time two other cases were removed to hospital "who had both partaken of cockles purchased from the same "man on the same day. These cases did not belong to the "same family, though they both belonged to the same district. "In both instances the attack was typical of the disease, and "in both cases Widal's reaction was present. The cockles were "the only source which could be assigned for these two cases.

"In the other three cockle cases the attacks were separate, "and came from widely separated districts of the town. The "cockles were the only traceable source of the disease.

"It is necessary to emphasise the fact that all these cases "occurred at the same time. Though careful inquiries were "made, it was not possible to discover who sold the cockles or "whether it was the same man in all the cases. It is also of "importance that during the time of occurrence of the cockle "cases no cases were notified other than those which were "ascribed to cockles, and that no cases during the rest of the "year could be traced to the influence of cockles.

"I am of opinion that these cases establish the fact that infected cockles must be recognised as a definite cause of a "certain proportion of cases of enteric fever.

"As a result of these inquiries, the Health Committee caused "posters to be issued and displayed in prominent position in "the town warning the public of the danger of consuming "cockles from the River Orwell.

"Whether these posters had any influence or not no further "cases occurred which could be traced to the influence of "cockles."

Subsequently—in September, 1908—the medical officer of health submitted to the Sanitary Committee of the Town Council a spècial report on the part played by cockles taken from the River Orwell in certain cases of enteric fever which has occurred in Ipswich, and in his report for 1908 he embodied the following table (now brought up to date) relative to enteric fever in Ipswich:—

Year	No. of cases notified.	No. of cases due to Cockles.	Percentage of Cockle cases.
1902	173	35	20
1903	45	5	11
1904	50	2	4
1905	50	9	18
1906	33	7	21
1907	33	9	27
1908	15	7	46
1909	15	2	13

He pointed out, too, that the greatest care had been exercised in including as cockle-borne cases only those in which the evidence was as complete as practicable, and he expressed the opinion that the number of cases attributed in the table to cockles really under-estimated the danger from this source. He added, too, that until this danger from cockles was effectually dealt with the excellent results as regards the prevalence of enteric fever which had accrued from the abolition of the privy system could not be fully appreciated. As a portion of the community still disregarded the warning notices issued by the Corporation, Dr. Pringle advised the Corporation to consider the desirability of endeavouring to obtain from the Local Government Board "such powers as may be necessary to enable you to effectually prevent the collection of cockles in certain portions of the River Orwell." On September 3rd, 1908, the Town Clerk, acting on the directions of the Public Health Committee, forwarded Dr. Pringle's report to the Board, with a request that the Board would assist the Corporation "in dealing with this very serious matter by issuing a Local Order, or whether it is in the contemplation of the Board to take legislative action as soon as the state of public business permits."

In his annual report for 1909 Dr. Pringle observes: "I am "convinced that the low prevalence of enteric fever in Ipswich "at the present time, in spite of the cockle menace, is due to "the substitution of the water-carriage system in place of the "privy-midden system, which, from its mere existence constitutes "a foul and abominable nuisance, and, from the point of view "of public health, stands condemned as a principle cause of "endemic enteric fever"; and he then furnishes a chart showing the relationship between the degree of prevalence of enteric fever and the number of privy middens. He insists that the only difference existing in the Ipswich of to-day with the Ipswich of the past in so far as enteric fever is concerned, is that "a high "degree of enteric prevalence was associated with the existence "of many privies, whilst a low degree of enteric fever pre"valence ensued on their practical disappearance."

Epidemiological Evidence relative to Enteric Fever alleged to have been caused elsewhere than at Ipswich by the consumption of Orwell Cockles.

During 1908 Dr. Cooper Pattin, medical officer of health of Norwich, drew the attention of the Board, *inter alia*, to a group of cases of enteric fever which occurred in that city from May to July, and in which the evidence, in his opinion, went to show that the cases were caused by the consumption of cockles (mainly from Ipswich) which reached Norwich viâ Lowestoft.

The total number of cases in this group amounted to 15, and the cockles were stated to have been procured from "H." and "S.," wholesale shellfish merchants, possessing also retail shops.

Dr. Pattin states that he had reliable evidence to the effect that cockles were imported from Ipswich from May 5th to June 22nd. The cockles, from whatever source procured, were as a rule consumed at a time which is not inconsistent with a view that the cockles and the enteric fever bore the relation of cause and effect to one another. Additional evidence in favour of the view that this group of cases was caused by the cockles in question is claimed for the fact that the issue of a warning notice on June 9th, and the destruction of the cockles on June 22nd, were followed by decline of the enteric fever.

Lowestoft.

During a prevalence of enteric fever at Lowestoft in 1908 one of the cases was alleged to have been caused by cockles from Ipswich.

THE LEIGH COCKLE TRADE.

For many years Leigh-on-Sea, near Southend, in Essex, has been the centre for the collection, preparation, and distribution of cockles from the mouth of the Thames, and an extensive trade is now done in these molluscs.

The Rev. R. G. King, rector of Leigh, who has taken great interest in this industry locally, tells me that at the present time (March, 1909) about three tons of cockles are despatched weekly from Leigh. The greater part of the cockles go direct to Billingsgate, and indeed this is the chief source whence the Metropolis obtains its cockle supply, but some go to Bristol and elsewhere.

The cockles are collected both on the Essex and Kentish sides of the Thames estuary. In Essex from the sands between Leigh and Southend and from the Maplin Sands south of the artillery range as far northwards as Foulness Sands. From the Kentish Coast they are gathered from Blyth Sand, to the south of Warden Point and off Whitstable Sands. All cockles thus collected are brought back to Leigh and prepared for market. It was formerly the custom to deposit the cockles collected from the above places on the bank of Leigh Creek, a creek which was then and is now polluted; the object of such deposit being to enable the cockles to free themselves from the sand contained between their valves. The cockles were then "boiled" in "coppers" and washed in the waters of Leigh Creek, as a consequence a material amount of enteric fever was attributed to Leigh cockles eaten at Southend and elsewhere, and after considerable publicity and in consequence largely of the prompt action on the part of the Fishmongers' Company the practice was discontinued, and the one now to be described introduced.

The cockles are now brought direct to the boiling sheds, the practice of laying them on the mud on the banks of Leigh Creek having been discontinued. Formerly the cockles were "boiled" in open coppers, but this process having, at times, proved insufficient to sterilise the molluscs, steaming by steam under pressure has now been substituted.

The apparatus in which the sterilisation now takes place consists of a boiler heated below by a fire, and from this boiler the steam is conducted to an iron steriliser which has what are in effect two ovens. Into each of these ovens is placed an iron tray filled with cockles, and the door being duly clamped, steam is turned on at a pressure of from 20 to 26 lbs., the process being continued for a period of five minutes, as indicated by a sand glass used for the purpose. At the termination of the prescribed interval the doors are unclamped and the tray, with its contents withdrawn.

The cockles, the shells of which are now quite open, are riddled through a riddle, the soft parts falling through into a tub of water, the shells remaining in the riddle to be thrown on to a heap outside the shed and used for making paths and for other purposes. The cockles are then washed in a series of tubs filled with water from the town supply, pickled with salt, enveloped in a white cloth, packed in baskets, and despatched to market. Formerly, as has been said, the water of the creek or rather of the Thames was used for washing the cockles, but the laying on of the public supply has enabled the use of the river water to be given up.

It is stated that these sheds, as well as the methods of the cockle boiler, are frequently inspected by an officer of the Fishmongers' Company, and that samples of cockles are from time to time examined bacteriologically under the auspices of the same Company.

Each consignment of cockles despatched to Billingsgate Market is accompanied by a certificate in the following terms:—

> "I hereby declare that the cockles contained in the
> "______________ hampers sent (or brought) by me to Bil-
> "lingsgate Market this day, the____________________were
> "taken from the______________________Sands at a point
> "known as the____________________; then taken direct
> "to my shed, where they were thoroughly cooked by
> "steam.
>
> "Signed ."

The number of persons employed in the shellfish industry at Leigh is given in a return prepared by the Sea Fisheries Committee for the Board of Trade at 110 males and 97 females wholly employed, and at 70 males and 32 females occasionally employed, and although not all these are concerned solely with the cockle industry a very large proportion of the total have some interest in these shellfish.

Apparently at the present time cockles are collected wherever they are found in the estuary, and such cockles after sterilisation are freely admitted into Billingsgate Market. The position taken up by the Company in question would appear in effect to be that the process of sterilisation removes the cockles from the uncooked and imperfectly cooked class to the class to which the floating fish, such as whitebait and mackerel, belong, and it will be seen directly that a somewhat similar attitude is taken up by the Southend Corporation with reference to the foreshore under their control.

SHELLFISH ON SOUTHEND FORESHORE.

Some years ago considerable quantities of shellfish—mainly oysters—were stored for growing and fattening purposes on the Southend foreshore, considerable rentals being paid for the right to do so.

But the attention drawn to the dangerous relation which such shellfish bore to the main sewer outfalls of the town and the numerous cases of enteric fever attributed to the consumption of the shellfish in question led to the layings being discontinued.

But, notwithstanding this fact, and in spite of notices exhibited on the foreshore warning persons of the danger of consuming shellfish collected thereabout, cases of enteric fever continue to be attributed to the consumption of shellfish picked up over the Southend foreshore; indeed, as lately as the year 1908, the present medical officer of health of Southend, Dr. Pugh, attributed 13 cases of enteric fever to this cause.

The Corporation have, I understand, considered how best to limit these unfortunate occurrences, and a provisional arrangement has, the medical officer of health tells me, been arrived at by means of which for a sum agreed upon the Corporation lets the foreshore to a syndicate subject to the non-removal of any shellfish, other than cockles, except for the purpose of relaying such shellfish for a sufficient period in other and purer waters.

As regards Southend foreshore cockles, the Corporation raises no objection to their sale by the syndicate provided such cockles are properly sterilised, and this the syndicate undertakes to have carried out.

It will therefore be of much interest to watch the behaviour of shellfish-borne enteric fever in Southend in the future now that the Leigh and Southend cockles are sterilised and the other shellfish on the Southend foreshore prevented from reaching the market except after relaying.*

MUSSEL AND COCKLE BEDS IN THE MEDWAY.

(Map No. 13.)

Control over the shellfish in the Medway estuary, except as regards certain of the creeks, is vested in the Corporation of Rochester, and such Corporation possesses power to let for purposes of shellfish cultivation any portion of the foreshore.

This right has for many years been exercised as regards a large portion of the estuary, and, excluding oysters, which are cultivated in creeks such as Stangate, Sharfleet, and Colemouth, extensive areas are let by the Corporation for mussel or cockle farming or gathering over Flats such as Bishop Ooze, Slede Ooze, and Hoo Flats. These areas are shown collectively under green colouration on Map 13.

Risks of Contamination.

The sewage of the towns of Rochester and Chatham is almost entirely disposed of by means of pervious cesspools, but as regards both these towns there are, I am informed, numerous overflows from the cesspools which find their way into the surface drains and thus to the Medway with the storm water.

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* Dr. Pugh, writing to me on August 9th, 1909, states that Southend had been quite free from enteric fever since the previous November with one doubtful exception, and on August 11th he writes to tell me that the tenant of the Southend foreshore has now determined not to take, or allow to be taken, any cockles from such foreshore.

The sewage of Gillingham, with a population of about 57,000, undergoes treatment by precipitation and filtration, the effluent being liberated into the Medway. There are also certain Government establishments on both sides of the river which, with the exception of that from Chatham Barracks which is precipitated and filtered, discharge crude sewage directly therein.

It must also be borne in mind that numbers of war vessels containing, some of them, considerable populations, are moored in one or another part of the Medway, and that such vessels must be sources of vicarious pollution to the waters of the Medway.

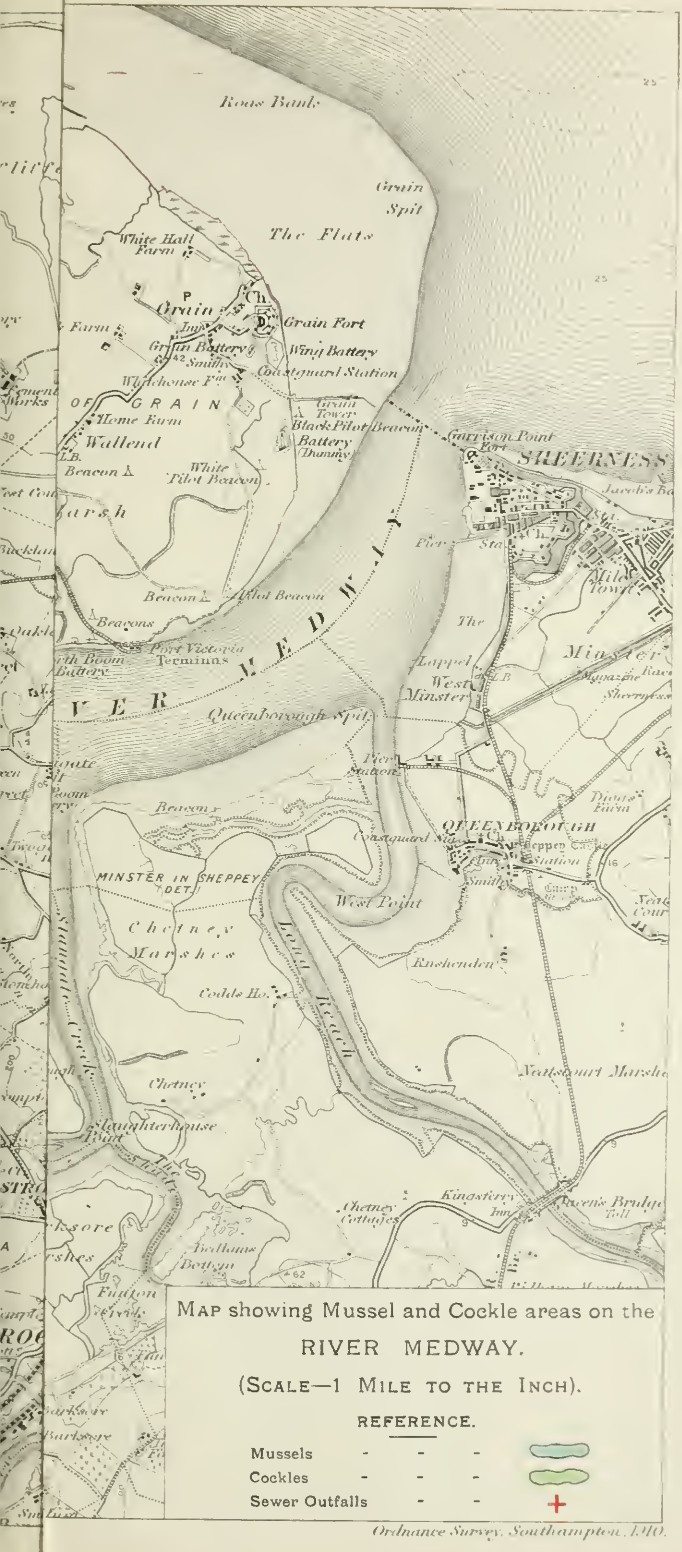
But on the other hand there is the important fact that the Medway is a wide and deep estuary even at quite low water, and the charts show that as far inland as Chatham Reach soundings of 14′ to 16′ are recorded at low water, while the width of the estuary ranges from a quarter of a mile in Chatham Reach to over a mile as the mouth is approached.

The result of these considerations is to show that the volume of water in the Medway when contrasted with the crude sewage of at most 60,000 people, means an enormous dilution at all times, and it is obvious that the greatest danger is to be anticipated from the collection of shellfish in the immediate vicinity of sewer outfalls, and this is a conclusion which is strongly supported by the epidemiological evidence shortly to be considered. The further fact that the mussels and cockles are upon banks which are only covered at the near high tide and which dry early on the ebb is one of importance. Still, when all this has been said, the fact remains that into the waters of the Medway round about Rochester and Chatham there is discharged a considerable volume of sewage, and, this being so, there must be risk from the consumption of shellfish collected from the more inland portions of the estuary and eaten imperfectly sterilised.

Epidemiological Evidence.

Dr. Pritchett, medical officer of health of Rochester City and Port, to whom I am indebted for much assistance, tells me that for several years past he has had reason to ascribe cases of enteric fever in Rochester to the consumption of shellfish—mainly oysters—collected near the Upton sewage outfall, which is at the junction of the Chatham and Cockham Reaches of the river. He has not, he adds, been able to trace any cases of enteric fever to shellfish collected from any such portions of the foreshore as are leased by the Rochester Corporation.

In his annual report for the year 1908, he states that a large proportion of the 59 cases of enteric fever notified in that year could be reasonably traced to the consumption of sewage polluted shellfish which were obtained from the unlicensed portions of the river at low tide. He remarks that the poverty existing in the district contributed to the prevalence of



MAP showing Mussel and Cockle areas on the

RIVER MEDWAY.

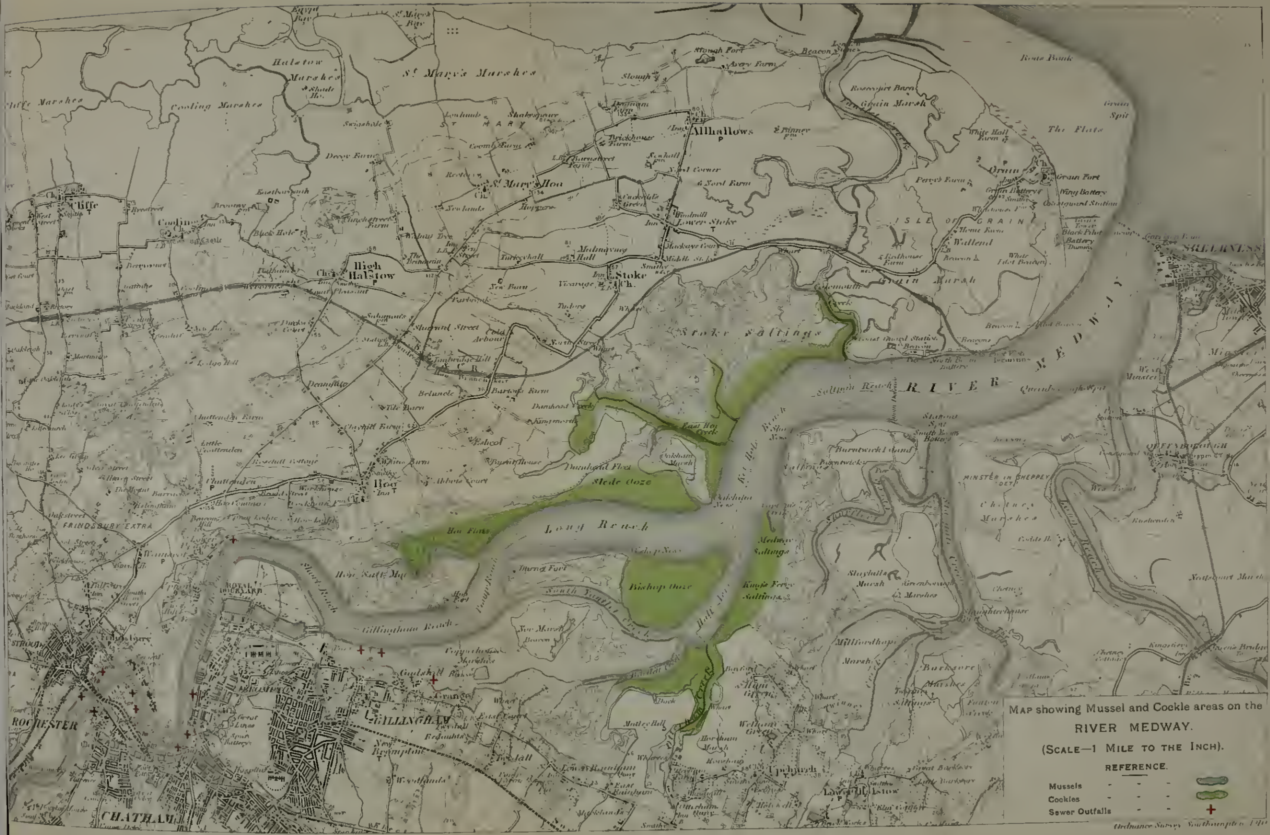
(SCALE—1 MILE TO THE INCH).

REFERENCE.

Mussels	- - -	🟦
Cockles	- - -	🟩
Sewer Outfalls	- -	+

Ordnance Survey, Southampton, 1910.

MAP No. 13.



Map showing Mussel and Cockle areas on the RIVER MEDWAY.

(Scale—1 Mile to the Inch).

REFERENCE.

Mussels - - - 🟩

Cockles - - - 🟩

Sewer Outfalls - - ✚

Ordnance Survey, Southampton [illegible] the disease, as people who are poor and hungry will take risk in the matter of food which they would refuse under happier conditions.

Dr. J. Holroyde, medical officer of health of the Borough of Chatham, in his annual report for 1908, attributes 18 cases of enteric fever to the eating of shellfish gathered from the Medway. The shellfish involved were mainly cockles, but in some instances clams and oysters. These molluscs are eaten in practically an uncooked state, since the cockles are only subjected to a temperature sufficient to open them. Many of the cases were of a very severe type. Notices were issued warning the public against the consumption of contaminated shellfish, and, later, a list of all the cases of enteric fever believed to have been caused by shellfish was published.

Dr. E. Warren, medical officer of health of Gillingham Urban District, observes, in his annual report for the year 1908, when there were 47 cases of enteric fever notified, that it was extremely difficult to trace the source of the disease, but he attributed "a few cases" to the eating of cockles which some boys had picked up on the river banks.

THE MUSSEL BEDS ON THE NORTH COAST OF KENT.

(Map No. 14.)

The mussel beds hereabouts, which are natural ones, extend at intervals from Whitstable to a short distance eastwards of the Reculvers, and they are situated in the positions indicated on Map No. 14.

The trade done from such of the beds as are uncovered at low water is mainly a local one, the mussels being sold in Canterbury and the neighbourhood. But in addition to these foreshore beds, there are others in deep water over the Kentish Flats, and situated for two to three miles from the shore. From these beds very large quantities of mussels are, in some seasons, dredged up and despatched to Billingsgate Market. Mr. Wheeler, the Fishery Officer of the Kent and Essex Sea Fisheries Committee, to whom I am indebted for the above data, informs me that as many as 50 tons of mussels may be despatched in one day from Whitstable.

Liability of the Mussel Beds to Pollution.

The risk of specific contamination to the deep water mussel beds on the Kentish Flats from the sewage of the towns on the north coast of Kent is but slight, but the mussel beds are liable to pollution in some degree from the sewage outfalls of Whitstable, Tankerton, and Herne Bay.

KENTISH COCKLE BEDS. (Map No. 14.)

The more important cockle beds in Kent are situated on the east of the Isle of Sheppey and on Whitstable Flats, and they are worked for the most part by the Leigh cockle gatherers, whose methods at Leigh have already been dealt with (see page 171).

But in addition to the beds off Sheppey and on the Whitstable Flats, there are smaller ones at intervals along the north coast of Kent in the positions indicated by green patches on Map No. 14, as well as in Pegwell Bay on the east coast of Kent.

The smaller beds on the north coast are frequented chiefly by those who dispose of the cockles locally, but those in Pegwell Bay are patronised by shellfish gatherers from Ramsgate, Margate, Deal, Sandwich, and elsewhere.

Liability of the Kentish Cockle Beds to Contamination.

The beds on the east coast of Sheppey would appear to be but little exposed to direct sewage pollution, and the same remark would apply largely to those upon Whitstable Flats, as also to those upon the north coast of Kent eastward of Whitstable.

But it is obvious that cockles may be collected too near to certain of the outfalls, and consequently there is here, as elsewhere, need for suitable regulations.

THE COCKLE BEDS OF PEGWELL BAY. *(Map No. 15.)*

Cockles are gathered over the sand of this bay both to the north and south by the mouth of the River Stour, as shown on map No. 15, the cockle gatherers coming mainly from Ramsgate, Sandwich, Deal, and Margate. The trade is by no means an extensive one, but it appears to have had material relation to the causation of enteric fever in Ramsgate. The cockles are taken to the cockle-gatherers' homes and boiled, after which they are hawked in the localities mentioned.

Risks of Contamination.

The nearest source of contamination is the main outfall of Ramsgate, a town with estimated population of 30,481 (1909).

This outfall—the only one—discharges in the position shown on the map at a point 1,260 feet from the shore. The outfall is continually discharging.

It will be seen that the outfall is distant about a mile from the nearest part of the northern cockle areas, and about two miles from the southern cockle areas, but it would certainly seem from the epidemiological evidence to be now considered that some of this sewage must at times reach the cockle beds.

Float experiments which were taken off the site of the outfall many years ago showed that on the first threequarters of the ebb the current runs seaward, *i.e.*, to the east, but that on the last quarter of the ebb, *i.e.*, when the sands are uncovered, the current is making for the mouth of the Stour, which river, however, at this time would be still running out and be at a level well below that of the sandbanks.

The experiments taken on the flood tides show that at half-flood the tide is making for the mouth of the Stour, although apparently before the mouth is reached the current turns outward again.

MAP No. 14.

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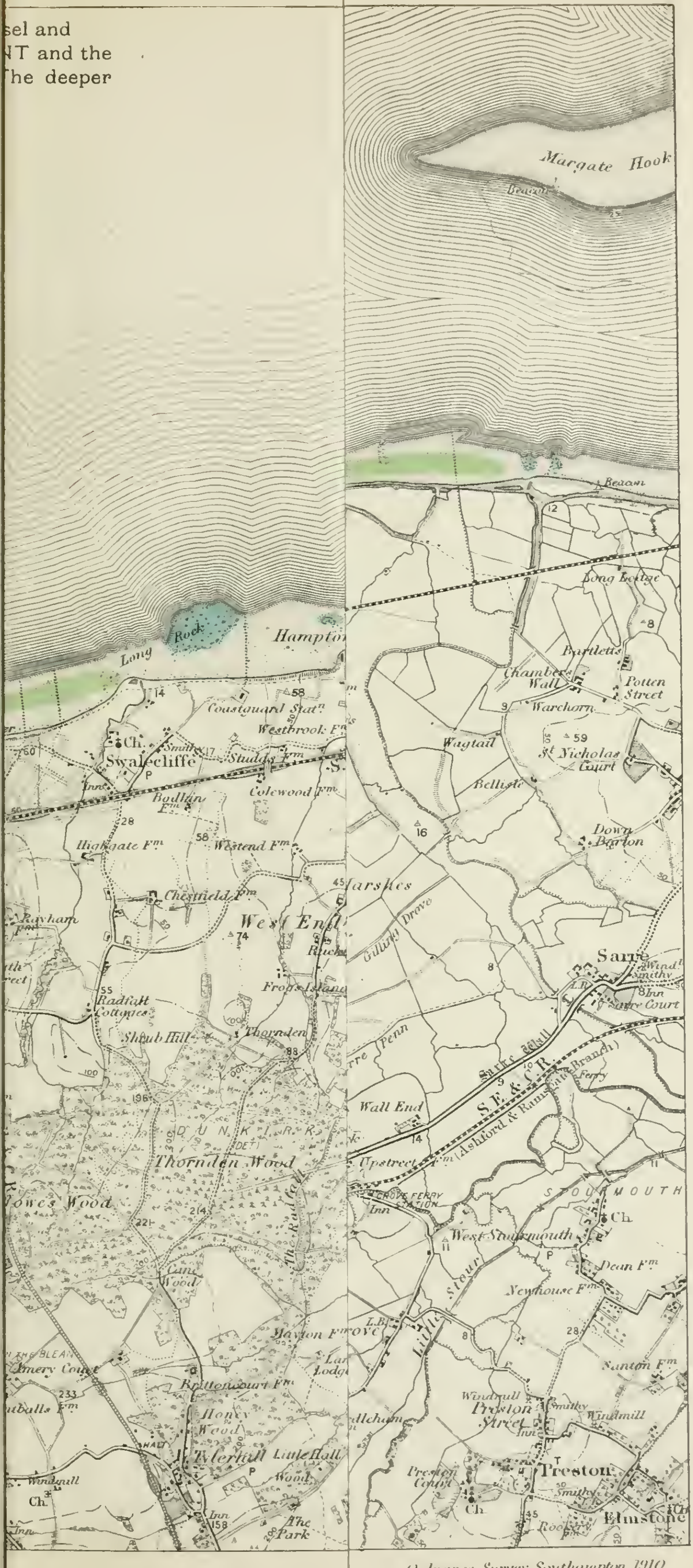
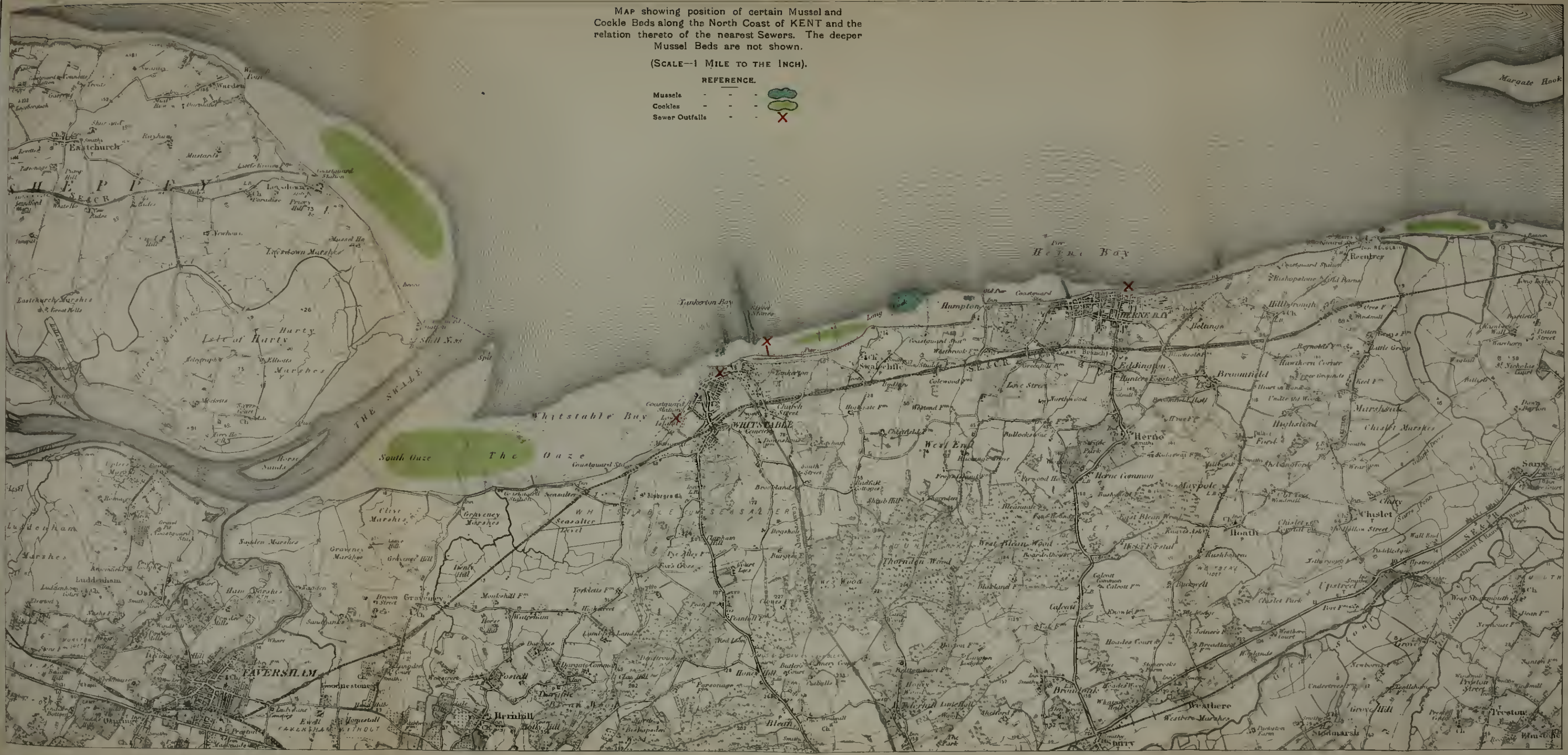


Ordnance Survey, Southampton, 1910.

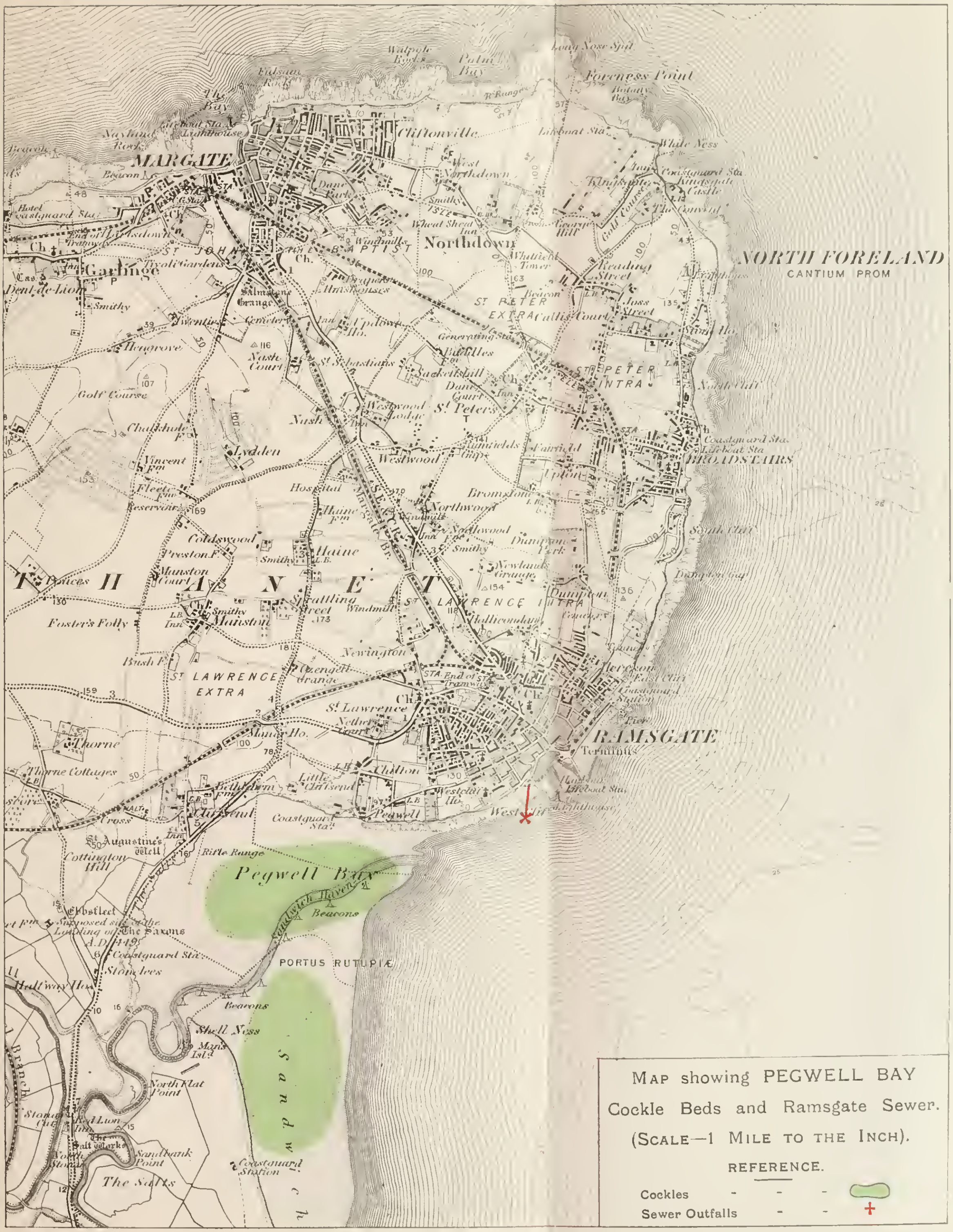


Map showing position of certain Mussel and Cockle Beds along the North Coast of KENT and the relation thereto of the nearest Sewers. The deeper Mussel Beds are not shown.

(Scale—1 Mile to the Inch).

(Ordnance Survey, Southampton, 1910)

MAP No. 15.



Map showing PEGWELL BAY Cockle Beds and Ramsgate Sewer.

(Scale—1 Mile to the Inch).

REFERENCE.

Cockles - - - 🟩

Sewer Outfalls - - +

Ordnance Survey, Southampton 1910.

In addition to the crude sewage of Ramsgate, there is also the slopwater of Sandgate to be considered, and perhaps, too, the sewage of Deal, some of which under certain conditions of tide and wind may be carried northwards.

Epidemiological Evidence as regards Pegwell Bay Cockles.

Dr. T. G. Styan, the medical officer of health of Ramsgate, in his annual report for 1905, attributes 10 out of 37 cases of enteric fever notified in that year to the eating of shellfish, and he adds that information reached him to the effect that at least five visitors who had eaten oysters or cockles during their stay in Ramsgate developed enteric fever after their return home.

The majority of these cases seem, however, to have been connected with the consumption of oysters.

In consequence of these cases an investigation was made as to the conditions under which shellfish were prepared, stored, and sold in the district; all the seven fish shops and nearly all the houses inhabited by licensed shellfish hawkers being visited. The shops were found to be satisfactory, and the majority of the premises of the shellfish hawkers were clean. But considerable differences were found with regard to the boiling of cockles. In some instances they were boiled for several minutes, in others the water was only just brought to the boiling point. In one instance the family washing was being conducted in the same utensils which were used at other times for the cleaning of cockles.

In his annual report for 1906, Dr. Styan gave the eating of shellfish as the probable cause of five out of 17 cases of enteric fever notified in that year. He stated that in each instance the shellfish in question were cockles, and that the evidence of infection was fairly conclusive. As an illustration of the evidence in question, he furnishes the instance of two boys who, on the Whit-Monday of that year, went to Pegwell Bay and collected a basket of cockles. One of the boys, though cautioned not to do so, ate a number of the cockles raw, and a fortnight later developed enteric fever. His brother refused to eat cockles raw, but took the remainder home to be cooked. Six persons ate the cockles after cooking, but none developed enteric fever.

A visitor staying at Pegwell for three weeks in September ate raw cockles in the Bay several times, although cautioned against it, and immediately after his return home developed enteric fever. Dr. Styan states that in order to minimise the danger from the sale of unwholesome shellfish he and the sanitary inspector visit the houses of the cockle hawkers at the beginning of each season and investigate the conditions under which the cockles are stored and prepared. The hawkers number about 30, and, generally speaking, the conditions are satisfactory. The sanitary inspector also visits the stalls in the streets and satisfies himself that a sufficient supply of clean water is available.

In 1907 two cases of enteric fever were ascribed to cockles, and in his annual report for 1908 Dr. Styan writes, "for the first time for several years I heard of no cases which could be traced to the eating of shellfish."

Dr. Alfred Mason, medical officer of health of Deal, in October, 1907, ascribed certain cases of enteric fever to the consumption of cockles collected in Pegwell Bay; and in his annual report for 1907 he states that warning notices had been exhibited, cautioning people against eating uncooked shellfish from this source. The sewage of Deal is held up in a storage tank, and liberated on the early ebb, when it takes a north-easterly direction.

In his annual report for 1909, Dr. Mason records but one case of enteric fever, and as to this he states: "The almost complete "absence of typhoid fever is the salient point in this section "of my report, and I attribute it to the fact that the inhabitants "have at last become aware of the grave danger of eating cockles "in a raw or half-cooked state. I ascertain, on enquiry, that the "quantity of cockles sold in this borough during the year has "been very small in comparison with former years."

THE MUSSEL SCALPS IN NEW SHOREHAM HARBOUR.

(Map No. 16.)

Mussels are collected hereabouts partly for human food and partly for bait, but only a few persons are now engaged in the business.

It is, in the main, immediately above and below the Shoreham Suspension Bridge that mussels are collected (see map No. 16). They are either gathered from the river bottom by means of a form of dredge which is fitted with a long handle and worked from a boat, or they are collected by hand at low tide.

On the occasion of one of my visits I saw boats collecting mussels in the fashion referred to near both the Shoreham Suspension Bridge and the Shoreham Railway Bridge, and one boat was at work not far from the Shoreham main outfall, which is situated a short distance above the Suspension Bridge, and around which there is a plentiful deposit of mussels.

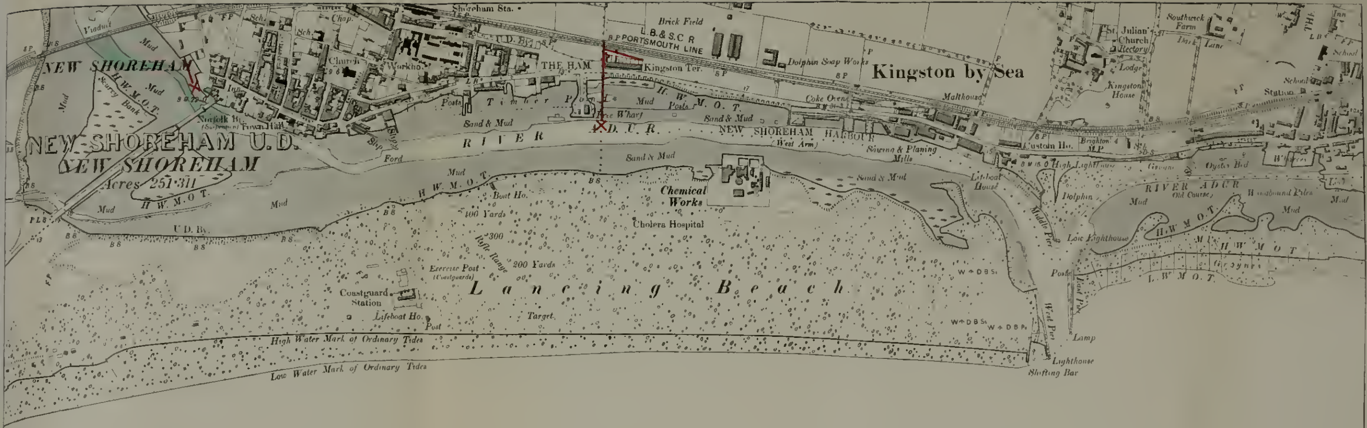
The mussels collected were, I was informed, formerly despatched direct to Billingsgate, but in 1909, Mr. Towse, Clerk to the Fishmongers' Company, informed Dr. Newsholme, that no Shoreham mussels had for several years been allowed into Billingsgate Market, owing to the fact that such mussels have been declared by Dr. Klein to be polluted. But a few are, it seems, sent to Brighton.

The sewage of Shoreham, which is almost wholly discharged between the two bridges above referred to, obtains no other treatment than passage through two small coke screens.

The process adopted does not give rise to much clarification of the sewage, and the specimen which I procured at the time of one of my visits was but little better than ordinary crude sewage. Clearly, straining alone takes place. The "effluent" is liberated at all such times as the tide will allow, so that probably some of it comes out during the first of the flood as well as at low water. I endeavoured to procure information as to the

HAM
am Main
ss.

MAP No. 16.



Map showing position of the SHOREHAM Mussel Beds in relation to the Shoreham Main Sewer—the most western red cross.

(Scale—6 Inches to 1 Mile).

REFERENCE.

Mussels - - - 🟩
Sewer Outfalls - - ✕

Ordnance Survey, Southampton 1910.

exact time when the tidal flap which covers the mouth of the sewer would be closed, but no observations appeared to have been made on the subject.

At the time of one of my visits to the outfall itself the men were engaged in clearing out the tanks, and the effluent was at that time extremely dark, but when the cleansing process was finished the effluent became a straw colour. I noticed these sudden changes in the colour of the effluent, and the well-marked line of demarcation between the river water and the effluent.

There is hereabouts a very strong "scour" in the river, and this naturally tends to carry the effluent rapidly seawards and to prevent it from becoming diffused over a wide area near the outfall.

The collection of mussels for human consumption from the vicinity of this outfall is clearly dangerous, but it would seem that mussels from this source were recently being sold in Brighton.

Epidemiological Evidence.

The mussels from New Shoreham have been shown by Dr. Newsholme, the former medical officer of health of Brighton, to have been responsible for numerous cases of enteric fever in that town, and references to these occurrences will be found in other portions of this report (see pages 35, 36 and 49).

Dr. C. R. Wood, medical officer of health of New Shoreham Urban District, refers in his annual report for 1908 to the heavy incidence of enteric fever in this district, and he observes that the consumption of polluted shellfish is undoubtedly responsible for a large percentage of such cases, although, he adds, suspicion attaches to the large number of water-closets unprovided with any flushing apparatus.

FORT CUMBERLAND MUSSEL BED NEAR PORTSMOUTH. (Map No. 17.)

Large quantities of mussels and cockles are collected from the foreshore some 300 yards south of the Portsmouth main outfall as well as over the coloured areas shown in Langstone and Portsmouth harbour on map No. 17, and Dr. Mearns Fraser, medical officer of health of Portsmouth, has drawn attention in his annual report for several years past to this unfortunate habit which is persisted in notwithstanding public notices and other warnings (see pages 55 and 56).

It seems almost incredible, Dr. Fraser observes, that persons may constantly be seen pulling up shellfish from a bank within 300 yards of the main outfall of the Portsmouth sewage at Fort Cumberland.

This sewer is supposed to discharge only on the ebbing tide, at which time it would pollute the shellfish on the "West Winner" sand, but it is possible that during neap tides there may be difficulty in getting rid of all the sewage on the ebb, and that some of it may be returned on the flood.

Dr. E. J. Hunter, medical officer of health of Gosport and Alverstoke Urban District, has drawn attention in certain of his annual reports to the fact that shellfish obtained from the creeks and harbours in the vicinity (see map No. 17) have been not infrequently eaten prior to enteric fever attacks, and on his recommendation warning notices have been issued which have, in his opinion, had the effect of diminishing the number of enteric fever thus associated.

THE ESTUARY OF THE EXE. (Map No. 18.)

This important Devonshire estuary contains considerable quantities both of mussels and of cockles, and on map No. 18 are indicated approximately the areas over which such shellfish may, at times, be collected. As regards mussels there is a process of farming or cultivation in vogue in this estuary, and it is a common practice to collect "brood" mussels from the deep channel opposite Exmouth, *i.e.*, between Exmouth and the Pole Sand, and to transplant them to the "layings" or holdings which exist on both sides of the Exe, over parts of the areas coloured blue on the map. The several plantations are marked off from one another by means of beacons or stones, a rent being paid by the lay-holders to the Lord of the Manor for the exclusive right of laying down mussels. The mussels are constantly tended by the lay-holders when they are exposed at low water, and they are moved from one part of the layings to another in order to promote the maximum growth of the molluscs.

The mussels when required for market are despatched by train from Lympstone station, and the quantities annually sent away from this station within recent years were, Mr. Quick, the sanitary inspector to the St. Thomas's Rural District, informs me, as follows:—

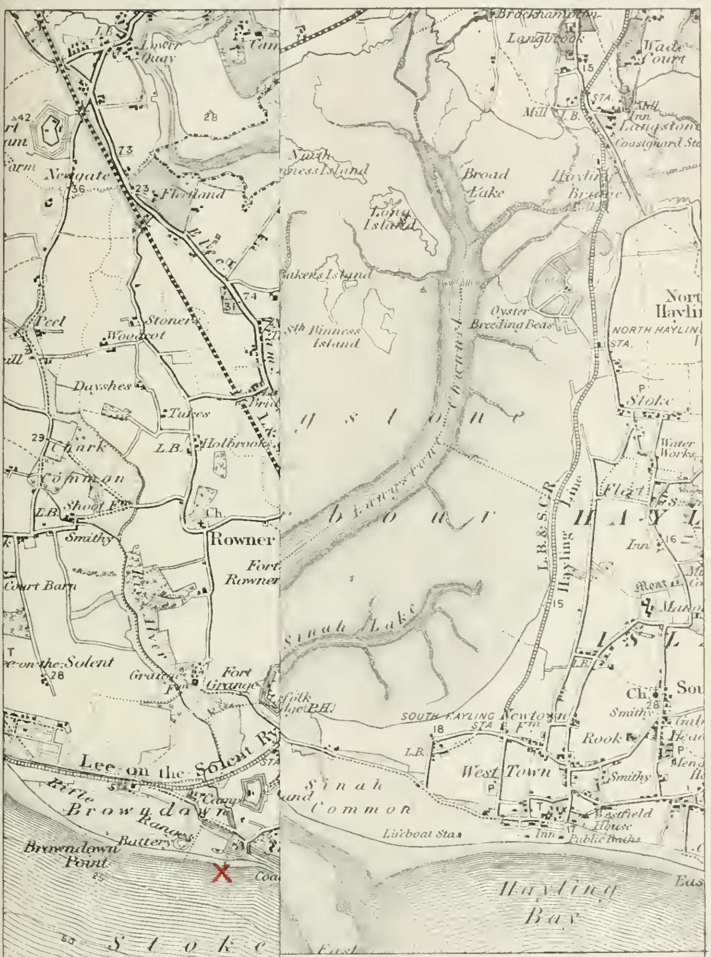
	Bags.
1905	740
1906	850
1907	800
1908	800

These shellfish go largely to Billingsgate and Nottingham, but those which are despatched from Starcross go, I am informed, to Exeter as well as to London.

There are some 33 persons engaged in the mussel industry in the Exe, *i.e.*, at Lympstone 29, at Starcross 2, and at Powderham 2.

The Pollutions entering the Exe between Exeter and Exmouth.

As map No. 18 will show, the Exe is a stream of no mean magnitude, and at its widest part it is fully 1½ miles across, the estuary at high tide presenting a lake-like expanse of water. At low tide, however, the water is confined largely to the main channel, although even then in the lower portion of the estuary there is a large body of water, the channel proper turning westward of the Bull-Hill Sand and then running eastward of the sandbank marked on the map as the Pole Sand. The tide enters and leaves the Exe with great velocity, and boats



MAP No. 17.

howing some of the sources from
ssels, Cockles, or Clams, are procured
or use in PORTSMOUTH.

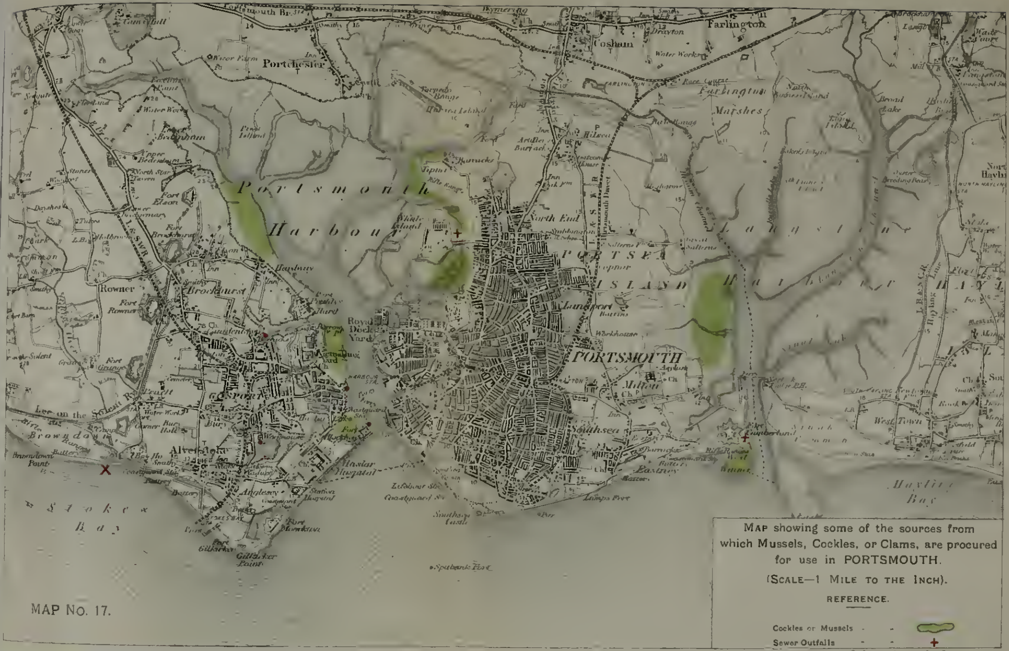
CALE—1 MILE TO THE INCH).

REFERENCE.

ockles or Mussels - - 🟩
ewer Outfalls - - +

Ordnance Survey, Southampton 1910.

MAP No. 17.



MAP showing some of the sources from which Mussels, Cockles, or Clams, are procured for use in PORTSMOUTH.

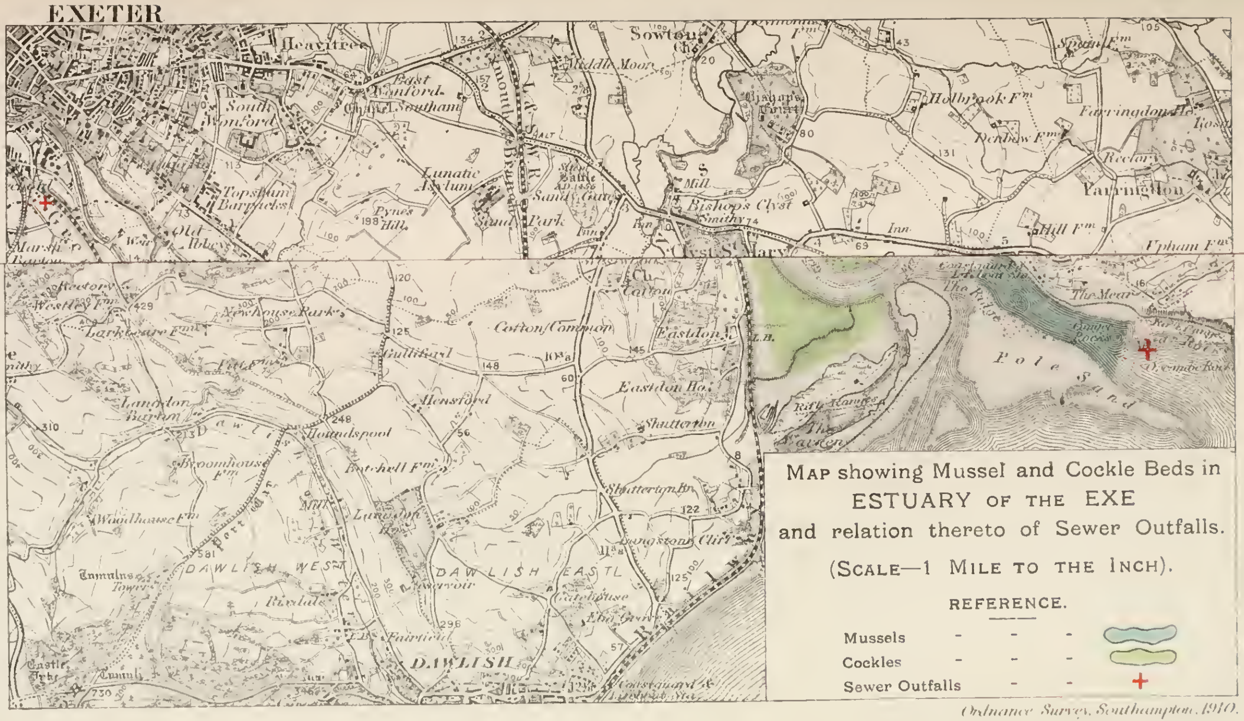
(SCALE—1 MILE TO THE INCH).

REFERENCE.

Cockles or Mussels - - 🟩

Sewer Outfalls - - +

Ordnance Survey, Southampton 1910

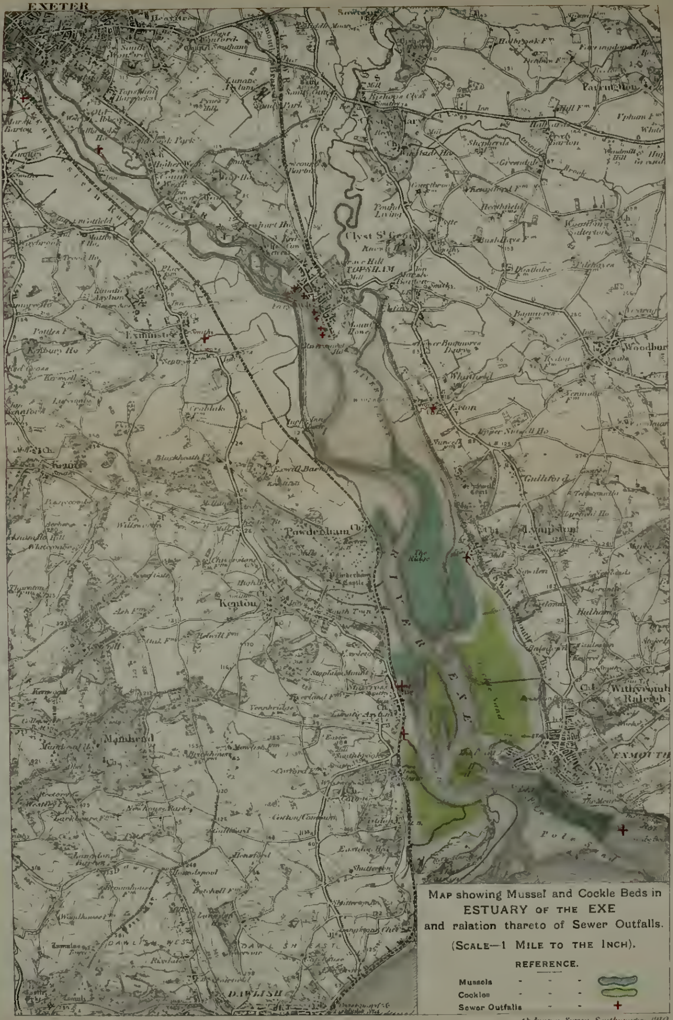


MAP showing Mussel and Cockle Beds in
ESTUARY OF THE EXE
and relation thereto of Sewer Outfalls.
(SCALE—1 MILE TO THE INCH).

REFERENCE.

Mussels - - - 🟦
Cockles - - - 🟩
Sewer Outfalls - - +

Ordnance Survey, Southampton, 1910.



MAP showing Mussel and Cockle Beds in
ESTUARY OF THE EXE
and relation thereto of Sewer Outfalls.

(SCALE—1 MILE TO THE INCH).

REFERENCE.

Mussels - - - ▨
Cockles - - - ▨
Sewer Outfalls - - +

Ordnance Survey, Southampton 1910

crossing from Exmouth to the Warren are carried by the tide far out of their course.

There is consequently an enormous interchange of estuary and sea water at every tide.

The most important contribution as regards sewage effluent is from the City of Exeter (pop. 48,793), the sewage of which is treated by septic tanks, contact filters and irrigation at two separate installations; one for Exeter east of the Exe, the other for Exeter west of the Exe. The effluent from the eastern side, which comprises a population of about 37,000, discharges into the Exe a short distance below St. James's Weir, about two miles south of the City, some six miles from the nearest mussel beds and eight miles from the nearest cockle beds. The effluent from the western or St. Thomas's side of the City discharges into a brook alongside the Great Western Railway line, and after traversing this brook for about two miles, it passes beneath the Exeter Canal and enters the Exe a short distance below Countess Weir, at a point four to five miles from the nearest mussel beds, and about seven miles from the nearest cockle sands. This same brook also receives some sewage from the village of Alphington.

The first actually crude sewage which enters the Exe direct is that from the village of Topsham, which has a population of about 2,000, the sewage of which is discharged crude by several separate outfalls. This village is distant about two miles from the nearest mussel beds.

At Lympstone, with a population of about 1,100, the sewage is discharged crude over the foreshore, and it can be seen traversing a form of rivulet across the sands until it reaches that channel of the estuary which is known as the Lake, which joins the main channel after a run of about threequarters of a mile. On either side of this Lake there are mussel layings.

At Starcross, with a population of about 1,000, there are two outfalls: one beneath the station and the other to the south of the village, while further south a stream from Cockwood bears down the drainage of that hamlet.

At Exmouth, which has a population of 10,485, there is one main outfall which discharges out at sea at all states of the tide in the position shown on the map, while inside the Exe is a storm outfall in the connection with the Exmouth low-level system, which discharges at times of heavy rain and of high spring tides. Formerly there was in this position a sewer outfall which gave rise to pollution of the foreshore, and which has been regarded as responsible for specifically fouling the "Cockle Sands" and for producing much cockle-borne enteric fever in Exeter.

Up to recent years there can be no question that many of the mussels despatched from the Exe were taken from sources obviously exposed to pollution; in fact, the sewer at Lympstone discharged practically into the midst of the mussel plantations thereabouts, and a similar remark applied to certain of the mussels deposited near Starcross. The attention of the Fishmongers' Company was drawn to the matter by the circumstances that some mussels collected from that estuary were regarded as polluted by the bacteriologist, and the Company threatened to close Billingsgate Market to the Exe mussels unless they were deposited for at least seven days on the higher parts of the sandbank known and marked on the map as "The Ridge." It was apparently concluded that as the higher parts of this Ridge are covered only after there is on the flowing tide a large body of water in the estuary, any pollution present would be reduced to a minimum.

Similarly, I understand that the mussel merchants on the opposite side of the Exe were asked to relay their mussels, prior to despatch to market, as high up on the foreshore as practicable.

There does not appear to have been any very definite areas either on the Ridge or elsewhere staked or beaconed out as quarantine grounds, nor does there seem to be anyone actually charged with the duty of supervising the movements of the shellfish stock, although I believe that an Inspector of the Fishmongers' Company makes surprise visits to the Exe, and that Mr. Quick, the sanitary inspector, does what he can to see that the suggestions of the Company are carried out.

At the date of my visit to the Exe there were no mussels being despatched from Lympstone as they were then out of season, but at Starcross I saw one of the merchants preparing to send mussels away—he alleged for bait—to Dawlish from what I should regard as an undesirable position, and he stated that he would also send mussels from the same spot for human food. Moreover, I saw mussels laid down on his beds in a position which could not fail to be reached on the flowing tide by the diluted sewage from Starcross.

As regards cockles I heard of no such quarantine regulations as have been suggested with respect to mussels, and it is quite clear that near Starcross and at Cockwood cockles are not infrequently collected from sands which are at times washed by diluted sewage from both these places.

In so far as the sands behind Exmouth are concerned, it is quite true that the diversion of the outfall which formerly discharged hereabouts has removed the main source of pollution from the "Cockle Sands," but the fact has to be borne in mind that the storm outfall in this locality is always a source of intermittent danger to the cockles in the vicinity by virtue of the fact that crude sewage may sometimes be discharged from such outfall.

The cockle areas which are probably least liable to dangerous pollution are the Bull Hill Sand and the sandbank exposed at low water immediately to the north of it, since there are no sewers discharging upon the sands thereabout and they are surrounded by a large volume of water even at low tide. But even as regards these sands it must not be forgotten that the sewage of Exmouth which is discharged at practically all states of the tide is liable on the flood to be carried back, albeit in an enormously diluted state, into the estuary of the Exe.

It would appear that if the risks which at present attend the consumption of shellfish from the Exe are to be materially reduced, it is necessary to definitely define the areas, if any, from which shellfish may be taken for immediate human consumption as well as areas from which they may be taken after a sufficient period of quarantine. One of the remedies which has been suggested is that the Local Government Board should declare the Exe to be a stream within the meaning of the Rivers Pollution Prevention Act, 1876, but as to this, as was pointed out in Chapter XII., it must be remembered that nothing which could be done in respect of sewage purification would be likely to render the Exe of such a degree of purity that its waters would at all times satisfy the bacteriologist, and that even after the expenditure of large sums of money on this part of Lympstone, Topsham, Starcross, and other smaller places it would still be quite unsafe to consume in a raw or even imperfectly cooked condition shellfish collected from the vicinity of any of the Exe outfalls.

Epidemiological Evidence relative to Shellfish from the Exe.

The main epidemiological evidence relative to shellfish from the Exe is that which relates to the consumption of cockles collected in the estuary near Exmouth.

Between July 1st and September 11th, 1899, there were 85 cases of enteric fever notified in Exeter, and of this number 58 had partaken of raw cockles either at Exmouth itself or procured from Exmouth, and some of the evidence relative thereto is set out on page 34.

In addition to the Exeter cases, Mr. M. Farrant, the medical officer of health, of what was at that time St. Thomas's Urban District, reported that nine children who subsequently developed enteric fever, visited Exmouth with a school-treat on August 9th, 1899, when they ate raw cockles. Seven of these children were notified as having enteric fever on August 28th and 29th and two on September 6th.

A year later, in his annual report for 1900, Mr. Farrant attributed two cases of enteric fever to the consumption of cockles procured apparently from the estuary of the Exe.

It would seem that the cockles here in question came for the most part from the Cockle Sand, over which at that time one of the Exmouth sewers, now converted into a storm overflow, discharged, and it is alleged that some of such cockles had been washed in the stream which took the sewage from part of Exmouth.

In his annual report for 1899,* Dr. Kempe, at that time medical officer of health of Exmouth, attributed 12 cases of enteric fever to the consumption of Exmouth cockles, and in the year 1900, Dr. F. M. Reynolds,† medical officer of health of Honiton, attributed two cases of enteric fever at Sidbury to eating cockles gathered at Exmouth.

Dr. Collingridge, medical officer of health of the City of London, who has paid much attention to the question of shellfish pollution, refers in his annual report for 1908 to a case of enteric fever which occurred in Wandsworth, and which was apparently attributed to the consumption of mussels supplied to a local dealer by a salesman in Billingsgate Market.

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* *Lancet*, Feb. 17, 1900.

† *Lancet*, 1900, vol. ii.

It was concluded that the mussels in question had been procured from places other than those advised by the Fishmongers' Company, and strict orders were given that in future all mussels for Billingsgate were to be procured only from the places approved by the Company.

SHELLFISH INDUSTRY IN THE ESTUARY OF THE TEIGN. (Map No. 19.)

This estuary which extends from Newton Abbot to Teignmouth, where it enters the sea, is rather more than 4½ miles in length, while in breadth it varies from a relatively narrow stream at Newton Abbot to an estuary almost ½ mile wide in its lower part.

There is in this estuary a very considerable shellfish industry, and I was informed by Mr. Rice, the representative of Messrs. Baxter and Sons, in London, that his firm pays for shellfish in the estuary over £600 per annum. There are three additional firms or individuals concerned with shellfish in the Teign, and they, together, pay, it is thought, a sum about equal to that paid by Mr. Baxter alone, *i.e.*, the amount paid out by these firms for shellfish derived from the Teign reaches annually over £1,200.*† This sum is, of course, considerably smaller than that derived by the merchants from the sale of such shellfish.

There are engaged in the industry about 100 individuals, and it is estimated that the total number of persons dependent in some degree upon the shellfish industry in the Teign is about 200.

The shellfish mainly dealt with in the estuary are mussels, periwinkles and cockles.

Mussels.

Mussels are distributed by nature in many parts of the river, but, generally speaking, the method of dealing with them is as follows:—

The most important natural beds are situated in the channel of the estuary over the last mile of its course, *i.e.*, before it enters the sea, and the most productive beds or "scalps" are located landward of the bridge connecting Teignmouth with Shaldon.

The mussels in the channel referred to are raked up by means of the usual long-pronged rakes, and, at times, several boats may be seen thus engaged above and below the Shaldon bridge. As a general rule the mussels thus raked up are not large enough for market, and they are therefore separated from the bunched condition in which they are brought to the surface and laid down for growth over definitely selected areas on the sands, situated between Coombe Cellars and the bridge, and which, drying at low water, enable the young mussels to be tended until they are fit for market. The different mussel "lays" are separated from one another by narrow paths or intervals, and no difficulties appear to arise as regards ownership.

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* *Lancet*, July 30, 1904.

† In a letter to the Local Government Board dated May, 1909, it is stated that the value of mussels alone placed in the bed of the Teign by fishermen amounts to between £2,000 and £4,000.

Sometimes, however, mussels are dredged from the main channel sufficiently large and in sufficiently good condition to allow of their being despatched direct to market.

Periwinkles.

These shellfish are as a rule introduced into the Teign from other sources and spread over certain areas of the sands for growth or storage; they are also found naturally in different parts of the estuary and collected therefrom.

Cockles.

These are found in almost all parts of the estuary from Coombe Cellars to its mouth, and more particularly on the sands which are exposed at low tide.

These cockles are collected and hawked in the neighbourhood. Large quantities are supplied with teas at Coombe Cellars on the western bank of the Teign, a favourite resort of trippers.

The Pollution of the Estuary.

The *main* sources of pollution are at Newton Abbot, Teignmouth and Shaldon, but there are also other places in the neighbourhood which contribute small amounts of sewage or slop-water.

The sewage of Newton Abbot (population 13,700) is passed through coarse wire screens and two sedimentation tanks. From here the separated fluid passes into a bacterial filter which is apparently always covered with sewage, and from there it is let out into the estuary after and before half-tide, *i.e.*, the effluent is being discharged for three hours on the ebb and five hours on the flood. The arrangement is an automatic one, and the valve closes and opens by the operation of the ebbing and flowing tide.

In times of storm a considerable portion of the sewage flows from the sedimentation tanks direct into a stream leading shortly into the estuary.

The Newton Abbot sewage contains much tan-yard refuse, and the presence of this matter is easily detectable by the colour of the sewage.

The effluent discharges into the estuary a short distance below the railway bridge.

The sewage of Teignmouth, with a population of some 7,232, is discharged by means of six separate outfalls into the estuary, and in no instance is any attempt made at purification. All these outfalls discharge into the channel, from which the mussels are dredged in the first instance, and in the case of the main outfall only is the sewage let out at a definite time, *i.e.*, on the first of the ebb.

The sewage at this outfall is stored during the greater part of the ebb and during the whole of the flow, and is liberated by means of a large outfall pipe. In the estuary hereabouts the tide ebbs and flows with considerable velocity, but, as in the case of the majority of the outfalls, the sewage is not held up, it is obvious that it must flow both up and down the river with the rising and falling tides. It seems to me that the sewer in each instance might well be carried a short distance further into the stream, a remark which applies more particularly to the main outfall.

At Shaldon, which has some 1,270 inhabitants, the sewage is discharged crude by four outfalls.

Risks of the specific pollution of the Teign Shellfish.

It will have been made clear that a very considerable amount of sewage effluent enters the estuary of the Teign at Newton Abbot, and of crude sewage at Teignmouth and Shaldon, while Coombeinteignhead and other villages contribute their portions, as also does the Inn of Coombe Cellars, the urinals and drains of which discharge on to the foreshore.

The volume of water at high tide is, of course, enormous, and the dilution of sewage and slopwater consequently great. Moreover, shellfish are not as a rule collected nearer to Newton Abbot than Coombe Cellars, a distance of about two miles from the Newton outfall.

But enough has been said to clearly show that under existing circumstances no small degree of danger must accrue from the consumption of shellfish collected promiscuously from the estuary of the Teign.

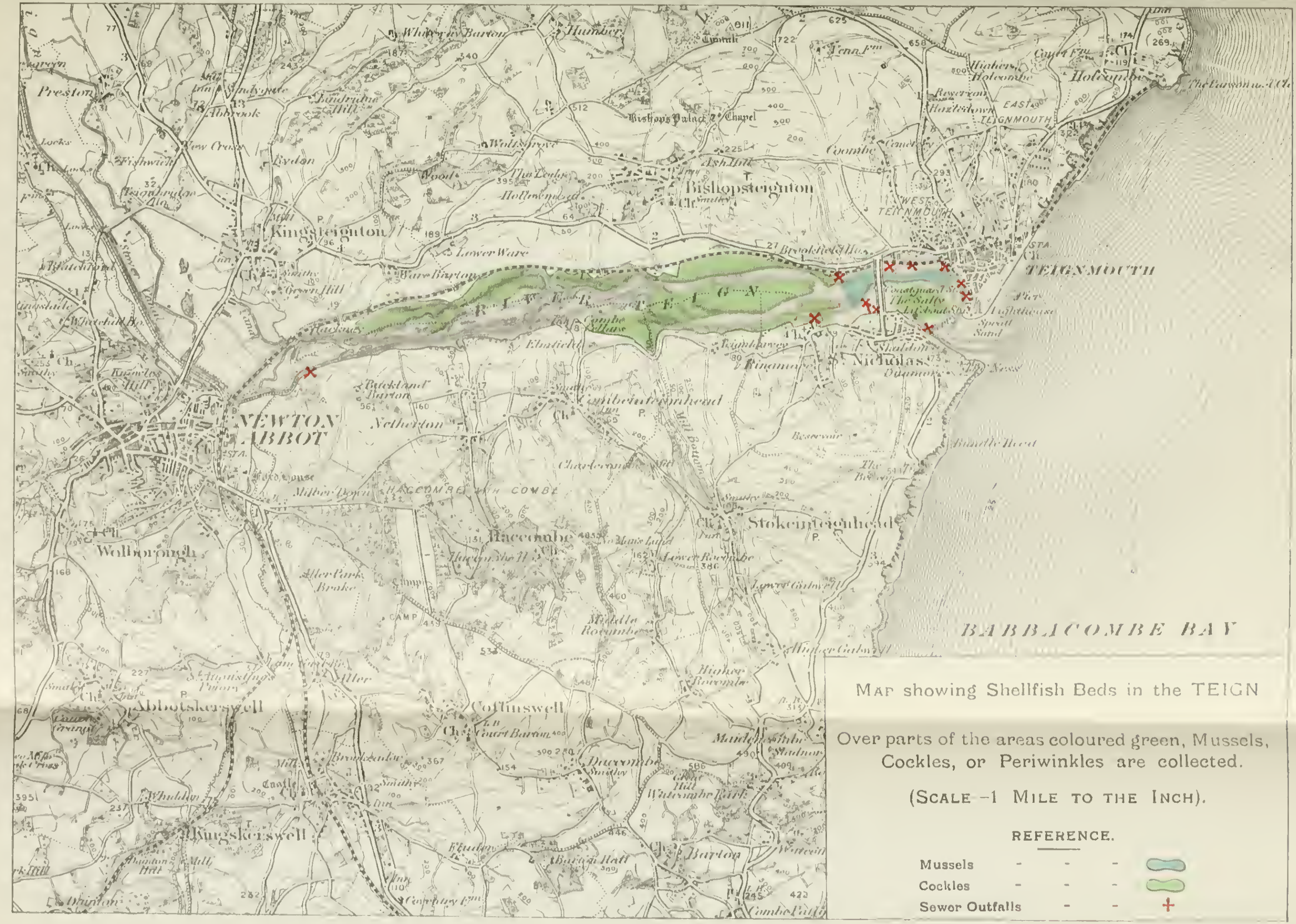
I am informed, moreover, by Dr. F. C. H. Piggott, the medical officer of health of Teignmouth Urban and Port Districts, that he has on several occasions seen bags of mussels which have been awaiting despatch to market stored in dangerous proximity to the Teignmouth main outfall. There can be no question that this is a procedure fraught with danger to the public health, but, unfortunately, in the present state of the law there would appear to be no means of preventing the practice.

Epidemiological Evidence as regards Teign Shellfish.

As far back as 1893, Dr. Piggott reported the occurrence of cases of enteric fever, which he attributed to the consumption of mussels collected from the immediate vicinity of a drain discharging from what was then the isolation hospital, and he has also since in many other years reported cases of the same disease in which the evidence tended to involve Teign cockles as the cause of the outbreak, and as recently as April, 1909, Dr. Piggott writes, " My personal conviction as to the importance of the " rôle played by cockles in the causation of enteric fever gets " stronger every year, and it is usually the first point to which I " direct my enquiries."

Mr. W. Harvey, late medical officer of health of Newton Abbot Urban District, in his annual report for 1898, records the circumstances of two visitors from London who were staying at Highweek, and who went in company with a local fisherman to a well-known river bank hostelry and there partook of cockles. The tradesman and the younger of the two London visitors underwent attacks of enteric fever within a day of each other; the remaining visitor only suffered from a severe and immediate attack of diarrhœa.

MAP No. 19.



MAP showing Shellfish Beds in the TEIGN

Over parts of the areas coloured green, Mussels, Cockles, or Periwinkles are collected.

(SCALE -1 MILE TO THE INCH).

REFERENCE.

Mussels - - - 🟦
Cockles - - - 🟩
Sewer Outfalls - - +

Ordnance Survey, Southampton 1910.

In 1902, 1903 and 1904, Dr. Harvey regarded 3, 2 and 2 cases respectively as probably due to shellfish, and in 1905 he chronicles a considerable increase of enteric fever largely due to two groups of cases associated with shellfish.

One group occurred in mid-September, in a house occupied by three adults and two children, and it was alleged that a fortnight prior to the attack two of the adults (the parents) and both children had eaten cockles gathered from the Teign, a little below Hackney, which is about ¾ mile from the Newton outfall. Both parents partook freely, but the children only had two or three each, and the remaining adult none. The father and eldest boy were taken ill the same day, but the mother not until a few days later. She was, however, said to have suffered from violent diarrhœa immediately after eating the cockles. The second child escaped entirely.

The three patients developed enteric fever of a very severe type, as also did the other adult, who is supposed to have contracted the disease from the patients who consumed cockles.

In the case of two other children who were attacked with mild enteric fever, the cockles were stated to have come from below Coombe Cellars.

ENTERIC FEVER IN TEIGNMOUTH AND NEWTON ABBOT.

Teignmouth. (*Population* 8,675 in 1908.)

Year.	Notifications.	Year.	Notifications.	Year.	Notifications.	Year.	Notifications.
1890 ...	11	1895 ...	15	1900 ...	3	1905 ...	12
1891 ...	7	1896 ...	13	1901 ...	5	1906 ...	4
1892 ...	19	1897 ...	16	1902 ...	8	1907 ...	13
1893 ...	10	1898 ...	18	1903 ...	6	1908 ...	10
1894 ...	21	1899 ...	—	1904 ...	12	1909 ...	3
Newton Abbot. (*Population* 13,700 in 1909.)							
1890 ...	6	1895 ...	9	1900 ...	3	1905 ...	11
1891 ...	6	1896 ...	12	1901 ...	14	1906 ...	11
1892 ...	9	1897 ...	9	1902 ...	15	1907 ...	5
1893 ...	9	1898 ...	40	1903 ...	16	1908 ...	4
1894 ...	25	1899 ...	3	1904 ...	6	1909 ...	1

In his annual report for 1905, as also in previous reports, Dr. Thomas Dunlop, medical officer of health of Torquay, drew attention to the fact that notwithstanding repeated warnings during every summer and autumn, cases of enteric fever due to eating cockles taken from the River Teign invariably occurred, and he stated that the same was reported by the medical officer of health of Newton Abbot.

In connection with the examination of this estuary, I am indebted to the kindness of Mr. S. A. Croydon, of West Holt, Teignmouth, who is a prominent member of the Committee of the Devon Sea Fisheries District and of the Devon County Council. Mr. Croydon was good enough to place his electric launch at my disposal, and also to secure, in addition to his own assistance, that of Mr. William Rice, a member of the Fisheries Committee, and of Mr. Taverner, the Fishery Officer. I am also indebted to

Dr. Piggott, the medical officer of health of Teignmouth, for much valuable information and for bringing my notes on this estuary up to date.

THE SHELLFISH IN THE RIVER DART. (Map No. 20.)

The estuary of the Dart extends from Totnes to the sea below Dartmouth and Kingswear, a distance in all of about 12 miles.

There is, I am informed by the Fishery Officer of the district, no regular industry in mussels or cockles in this estuary, but although this is so, considerable quantities of mussels are collected mainly for bait at places from the mouth of the river to as far up as Stoke Point, some three miles south of Totnes, and at Dittisham there is a definite mussel bed. No storage or relaying of mussels takes place.

As regards cockles they are gathered from June to November by about six women on the sandbanks which are exposed at low water between Dittisham and Bow Creek and, notably, on the extensive sandbank known as the "Flat Crow," which is situated a short distance to the north-east of Dittisham.

The cockles are taken to Dartmouth and there hawked at about 4*s*. per bushel.

Pollution of the Estuary.

Time has not allowed of a detailed inspection of this estuary, but at Dartmouth a population of some 7,000 discharges its crude sewage into the Dart by means of numerous different outfalls extending from Warfleet Creek on the south to the new Naval College on the north, while on the opposite bank of the estuary there is the population (about 500) of Kingswear discharging its crude sewage.

There are also numerous vessels in the harbour which must in some degree add to the pollution.

THE SALCOMBE ESTUARY. (Map No. 20.)

This estuary extends from Kingsbridge on the north to the sea, beyond Salcombe, on the south, a distance of about six miles, and there are also passing into the estuary or harbour several important branches such as Frogmore and Southport Creek as well as others of smaller dimensions.

Cockles are, Dr. Pearce, the port medical officer of health, informs me, collected over the mud flats on the eastern side of the channel and about one mile below the Kingsbridge main outfall, and Dr. W. H. Webb tells me that they are also collected opposite the outfall as shown on the map.

Kingsbridge has a population of some 3,000 and empties its sewage crude into the estuary about a mile below the town, while Salcombe, with a population of about 1,820, empties its untreated sewage into the harbour by numerous small outfalls.

Epidemiological Evidence.

Dr. Webb, the medical officer of health of Kingsbridge, in his annual report for the year 1899,* attributed one case of enteric fever to the eating of raw cockles collected from the mud

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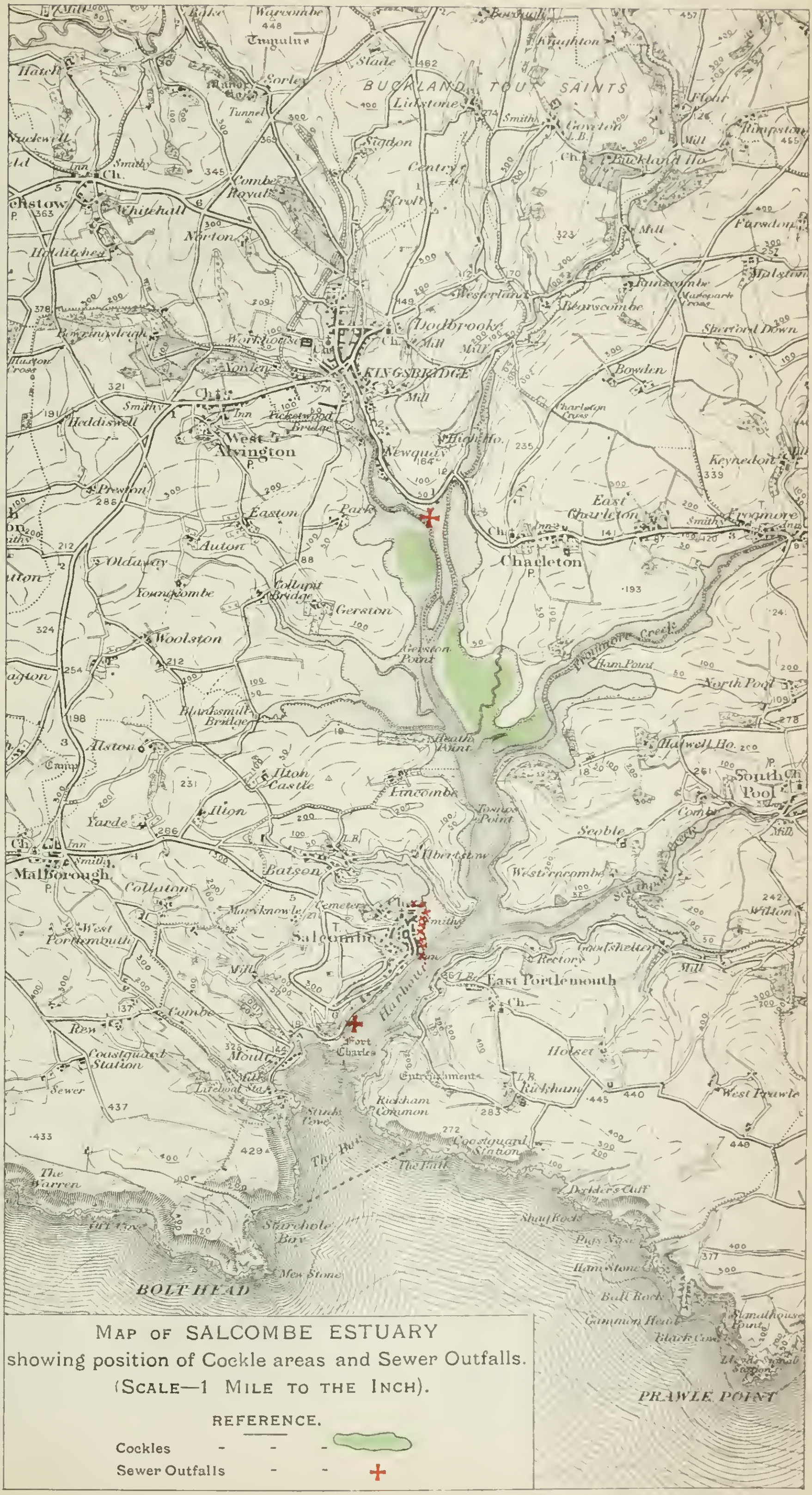
* *Lancet*, March 17, 1900.



MAP OF SALCOMBE ESTUARY showing position of Cockle areas and Sewer Outfalls.

(SCALE—1 MILE TO THE INCH).

REFERENCE.

Cockles - - - 🟩

Sewer Outfalls - - +

Ordnance Survey, Southampton 1910.

banks in close proximity to the Kingsbridge sewer outfall, and other cases were reported to have occurred in the summer 1901 and in 1909.

Owing to what he regarded as a grave danger, he caused handbills to be circulated warning the population against the practice of collecting for food shellfish from those places, and since then no cases of shellfish-borne enteric fever have been brought to his notice.

Dr. Pearce, the medical officer of health of Kingsbridge and Salcombe, has been unable to ascribe any enteric fever to the consumption of shellfish collected in the estuary.

THE RIVERS AVON AND ERME.

A few cockles are collected hereabouts and sold locally. There are, the inspector reports, abundant cockles in the Avon, but the cost of carriage precludes a profit from their collection.

THE RIVER YEALM FROM STEER POINT TO KITLEY QUAY.

There is, the Fishery Officer tells me, one man habitually engaged from June to November as well as during the winter in collecting cockles and mussels in this estuary, and other persons do so casually. The shellfish so collected are sent to Plymouth.

ESTUARIES OF THE PLYM AND THE TAVY.

Small quantities of mussels and cockles are collected hereabouts at irregular intervals by casual workers, and they are either consumed by the collectors themselves or sold locally.

MUSSELS AND COCKLES IN THE PENRYN RIVER, CORNWALL.

Although there is apparently no definite trade in either of these molluscs from the river in question, such shellfish are from time to time collected therefrom and consumed. The mussels are collected from the rocks beneath the granite works at Penryn, while the cockles are mainly gathered from the mud flats on the opposite side of the river between Penryn and Trevissons.

Risks of Contamination.

These are great, as the sewage of Penryn is discharged in proximity both to the mussels and the cockles.

Epidemiological Evidence.

Dr. Jomes Blamey, medical officer of health of Penryn and of the East Kerrier Rural District, referred in his annual report for 1899 for the latter district, to the case of a patient developing enteric fever 14 days after eating Penryn cockles, and he states that his opinion relative to the cause was strengthened by the fact, that at precisely the same date two or three cases of enteric fever occurred in Penryn, and in every instance cockles had been previously consumed. All the patients ate cockles about August 25th, and all became ill on or about September 8th.

Dr. Blamey adds, that on more than one occasion in previous years he has attributed cases of enteric fever to the same practice.

The owners of the granite works had done all in their power to prevent shellfish eating by their workmen, and Dr. Blamey had felt it his duty to call the attention of the Penryn Town Council to the matter.

In his annual report to the Penryn Town Council for the year 1901, he refers to a case of enteric fever which he was inclined to attribute to the consumption of Penryn river cockles, and he also mentions another case where toxic symptoms had followed this practice. He characterises the practice of eating cockles from this river as a most dangerous one.

It has to be pointed out that the Penryn river is not the source from which Penryn and Falmouth is supplied with cockles, and Dr. Blamey tells me that practically all of these molluscs, which are eaten in this vicinity, come from the Helford River.

ENTERIC FEVER CASES IN PENRYN URBAN DISTRICT.

Year.	Cases.	Year.	Cases.	Year.	Cases.	Year.	Cases.
1892 ...	40	1897 ...	2	1902 ...	2	1906 ...	2
1893 ...	9	1898 ...	10	1903 ...	—	1907 ...	—
1894 ...	45	1899 ...	10	1904 ...	—	1908 ...	—
1895 ...	7	1900 ...	—	1905 ...	1	1909 ...	—
1896 ...	5	1901 ...	3				

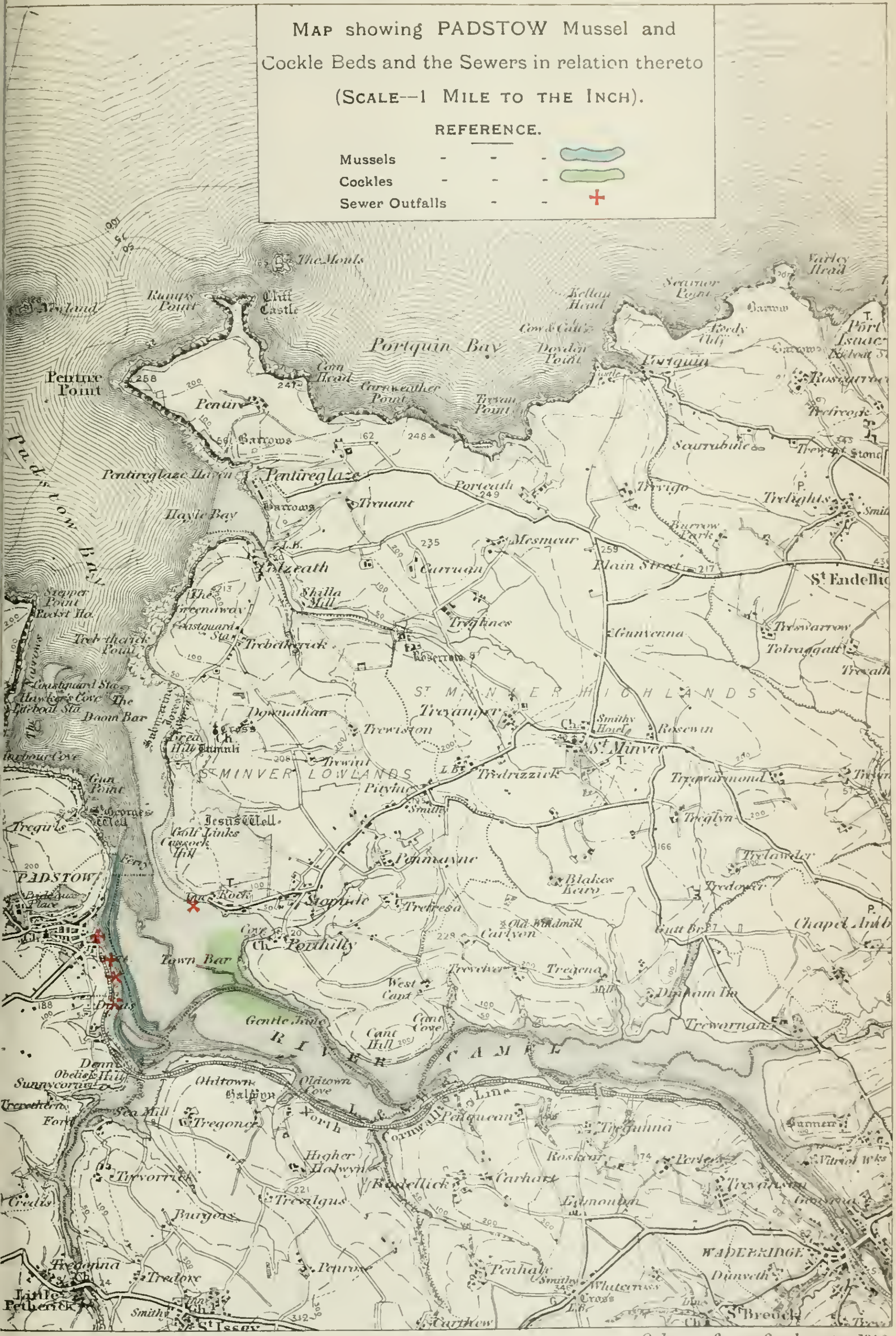
MUSSEL AND COCKLE BEDS IN THE PADSTOW ESTUARY, CORNWALL. (Map No. 21.)

I am informed by Dr. F. Harvey, medical officer of health of the port and town of Padstow, that mussel beds extend in the estuary of the Camel from the railway bridge to Chapel Style, as marked in blue on Map No. 21, and that the mussels collected over this area are despatched to Plymouth, Redruth, Camborne, and, occasionally, to Bristol, as well as being hawked locally. The mussels, which are in the bed of the channel, are dredged for with long rakes, used from boats. There are three men, more or less, engaged in the industry; one of them is permanently employed in the work, another is so employed for about four months, and the other for two months.

As regards cockles, there is a bed on the St. Minver side of the estuary near Cove, the cockles being collected mainly in the summer and sold locally.

Risks of Contamination.

The medical officer of health, who has been good enough to mark the accompanying map for me, states that there are four sewers or drains discharging into the mussel area, *i.e.*, the main sewer which takes the drainage of some 1,500 people, the Avery Row sewer serving about 70 people, and the South-Western Hotel sewer, serving, perhaps, in all 40 people, now discharge together through one pipe—formerly they emptied separately, as shown on this map.



Map showing PADSTOW Mussel and Cockle Beds and the Sewers in relation thereto

(Scale—1 Mile to the Inch).

REFERENCE.

Mussels - - - 🟦

Cockles - - - 🟩

Sewer Outfalls - - +

Ordnance Survey Southampton, 1910.

The most southerly sewer has only been recently constructed, and at present only two or three houses drain into it.

The main mussel bed is situated northward of the main or northern sewer from which it is distant about 100 yards.

All the sewers are covered except for a few hours at low water of spring tides.

There can be no doubt, the medical officer of health states, that the mussels are sewage fed, and it may be noted that at one period the mussels failed to sell because of their tarry taste, a circumstance which was due to the fact that liquor from the gas works discharged into the main sewer.

On the opposite side of the river there is a sewer from Rock discharging to the north of the cockle bed in the portion indicated by a red cross.

Epidemiological Evidence.

Dr. Harvey states that he has never known of any illness attributed either to mussels or cockles, and that there has been. with the possible exception of one mild case, no case of enteric fever in Padstow for 15 years.

SHELLFISH INDUSTRY IN THE ESTUARIES OF THE TAW AND TORRIDGE, NORTH DEVON. (Map No. 22.)

Both mussels and cockles are collected in each of these estuaries over the areas coloured blue and green, respectively, in Map No. 22, and it will be seen that the mussels are found in the bed of the channel which forms the common mouth of both estuaries from the western end of Appledore to about half-a-mile seaward of the lighthouse. They are also found at intervals in the Taw, from the point at which it joins the Torridge to as far up towards Barnstaple as Allen's Rock, while in the estuary of the Torridge they are found in the main channel from opposite Instow Quay to opposite Westleigh. Over practically the whole of this area, with the exception of Allen's Rock, where they are hand-picked, the mussels are collected by means of a long rake, such as is used in many other estuaries, and which is known locally as a "Clum," the process of raking for the mussels being known as "Clumming."

The mussels when collected are despatched by train from Instow, Barnstaple, and Braunton, and among the towns to which they go are Bristol, Birmingham, Manchester, London, and Exeter.

There are about 24 persons engaged in the industry.

No mussels may be collected from this locality from the 1st of March to the 31st of July, inclusive, and at no time may mussels under two inches in length be taken. They may only be gathered by hand or with the "Clum," which must not exceed 2 feet in width or have teeth less than 1½ inches apart at any point, and this instrument may only be used when the mussels are covered by at least 4 feet of water.

Cockles are collected at places and at times over the areas coloured green on the map. About 30 persons, mostly women, are stated to be engaged in the collection of these shellfish which are partly despatched to Exeter and partly disposed of locally.

There are no byelaws relative to the period of collection of cockles, but they may only be gathered by hand or by a spoon or rake, and there is a minimum size limit in force.

I am indebted to Fishery Bailiff Piddler, of Instow, and to Fishery Officer Piddler, of the Devon Fisheries District, for the above information.

The Pollution entering the Taw and the Torridge.

The main pollution directly entering the estuary of the Taw is that contributed by the city of Barnstaple, which has a population of about 15,000. The sewage is discharged by three separate outfalls—the Station outfall draining about 12,000, the Pottinger outfall about 2,500, and the Sticklepath outfall, which is on the southern side of the estuary, about 500. All this sewage, with the exception of that from Sticklepath, which is treated by alumino-ferric, is discharged at present in a crude condition, and at all states of the tide except at spring tides, when it is held up for about three hours.

These outfalls discharge at a point from 3 to 4 miles from the nearest mussel beds, and about 2 miles from the nearest cockle sands.

On the northern side of the Taw, the only other pollution of importance, which gains access to the estuary, is the sewage of Braunton, a village with a winter population of about 1,500, and a summer population of some 3,000, and which discharges its crude sewage into Braunton Pill at a point, as the Pill runs, about two miles from the main channel of the Taw.

On the southern side of the Taw the sewage of the village of Bickington enters the Pill, which discharges into the estuary near Fremington Station, and this same Pill, Mr. Kingwels informs me, takes the drainage of about eight houses in Fremington.

Into the estuary of the Torridge there discharges by means of two separate outfalls the crude sewage of the town of Bideford, with a population of some 9,500, while lower down, on the eastern side, discharges the sewage of Westleigh (population 150), and the sewage of Instow (population from 500 to 1,200, according to season). This latter outfall discharges at Instow Quay, and the crude sewage can be seen traversing the foreshore and entering the main channel.

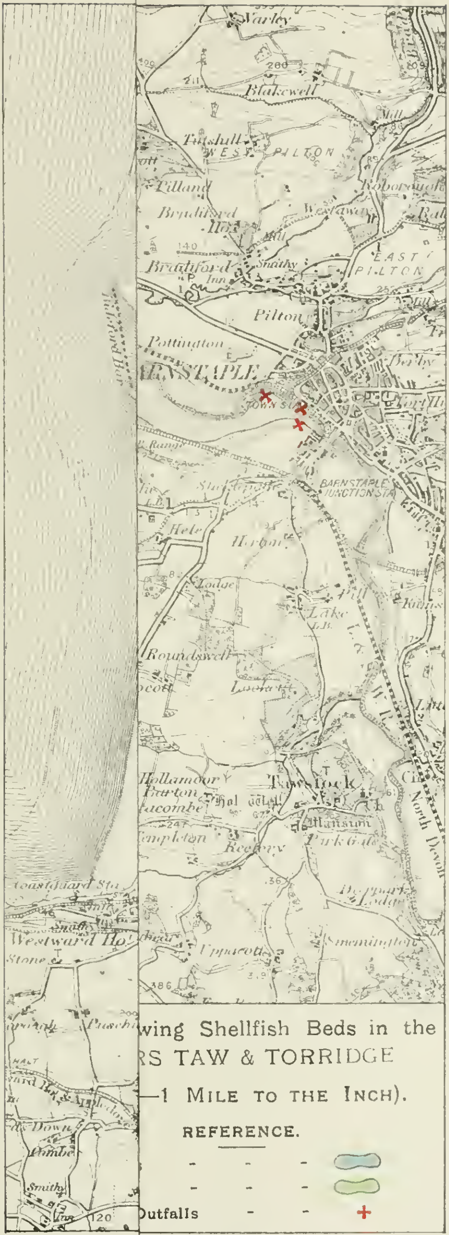
On the western side of the Torridge, below Bideford, there discharges about a mile below Bideford the sewage of Cleaves Houses, with a population of 693, and near the junction of the Torridge with the Taw, there discharges, by means of five relatively large and four minor outfalls, the sewage of Appledore, which has a population, Dr. Toye informs me, of about 2,627.

Mr. Champion, the surveyor, tells me that none of these outfalls actually reach low-water level, all of them discharging over the rocks or sand.

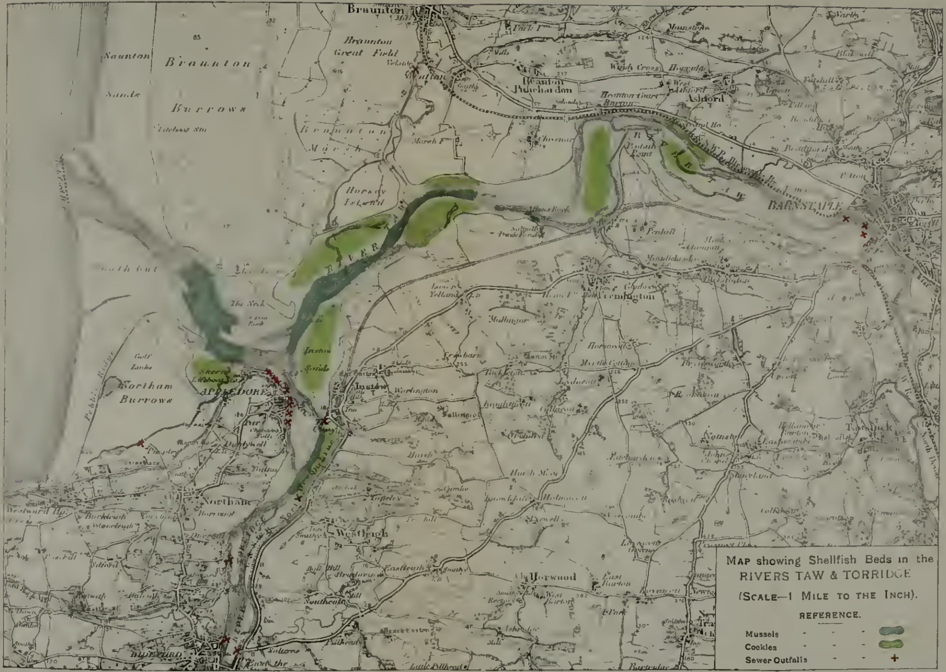
Seaward of these Appledore outfalls, there is a creek shown on the map which crosses the sands known as the "Skern," and this creek takes, either directly or indirectly, the sewage both of Westward Ho! and Northam.

That of Westward Ho! (population, 750) passes through a tank where it undergoes screening and some sedimentation, and

MAP NO. 22



Ordnance Survey, Southampton, 1910.



Map showing Shellfish Beds in the RIVERS TAW & TORRIDGE

(Scale—1 Mile to the Inch).

REFERENCE.

Mussels - - - 🟩
Cockles - - - 🟩
Sewer Outfalls - - - +

Ordnance Survey, Southampton 1910

it then traverses Northam Burrows in an open channel until it reaches the rivulet draining the Goose Pond, after which it enters the mouth of the Taw and Torridge across the " Skern " Sand. The sewage of Northam reaches untreated the same rivulet but nearer to Appledore, and its course subsequently is identical with that taken by the Westward Ho! sewage. This Northam sewage (population, 1,213) traverses numerous ditches on the way to the rivulet in question, and much of it is, I am told, used at times by the farmers for the purposes of irrigation.

Risks of Contamination of Shellfish by Sewage.

It is clear from the preceding statement that, more especially in certain localities, shellfish in both the Taw and the Torridge are liable to be polluted by sewage, a remark which applies with special force to shellfish collected in the channel or over the sand banks near Barnstaple, to those collected near the Instow and Westleigh outfalls (in the Torridge) and to the shellfish gathered over the " Skern " sands. Neither the Taw nor the Torridge can, except in the vicinity of the several sewers, be regarded as highly polluted estuaries, and the sands are, for the most part, clean. But in dealing with food eaten raw, a state of pollution which may not be very serious from the point of view of nuisance or in producing ill-health among those who live upon its banks, may be a matter of vital importance.

So long as the Taw and the Torridge continue to contribute shellfish for consumption, raw, to the public market, it is absolutely essential that no shellfish shall be gathered near Barnstaple or anywhere in the vicinity of the Instow, Westleigh, or Appledore sewers, and that the " Skern " should be avoided in the same sense.

Epidemiological Evidence.

Dr. Gooding, the medical officer of health of Bideford, informs me that he has at no time had reason to attribute any enteric fever or other illness to the consumption of shellfish.

Dr. Toye, medical officer of health of Northam Urban District, which embraces Northam, Westward Ho!, and Appledore, has been unable to trace any disease to shellfish. There has not, he states, been any genuine case of enteric fever in the district since the introduction of the new water supply in 1902.

Dr. Harper, medical officer of health of Barnstaple Urban and Rural Districts, states that during the last three or four years, cases of enteric fever in Barnstaple have been traced to the consumption of mussels or cockles obtained from the Taw, more especially from the beach on the north bank of the estuary, opposite Fremington Quay, and, consequently, notices have been issued drawing attention to the danger of eating raw shellfish. Apparently, no question as regards shellfish arose until 1906, when, out of 15 cases, one was attributed to eating raw cockles, and one to bathing near one of the sewer outfalls.

In 1907 out of 15 cases two were attributed to eating mussels; in 1908 out of only four cases notified, two followed upon the eating of raw cockles, and in 1909 one case out of six was attributed to eating uncooked shellfish.

Dr. Harper states that raw shell-fish are looked upon as a delicacy by poor people of the town, amongst whom, until recently, since the isolation hospital has been open, there has been great difficulty in preventing the spread of the disease.

In the Barnstaple Rural District, which includes Instow and Braunton, where enteric fever is much less prevalent than in the town, only one case—and that in 1903—followed the consumption of shellfish.

The following cases of enteric fever have been notified in the Barnstaple Urban and Rural Districts within recent years:—

Barnstaple Urban. (*Population* 14,137.)

Year.	Cases.	Year.	Cases.	Year.	Cases	Year.	Cases.
1896 ...	3	1900 ...	15	1904 ...	4	1908 ...	4
1897 ...	18	1901 ...	9	1905 ...	27	1909 ...	6
1898 ...	3	1902 ...	15	1906 ...	15		
1899 ...	18	1903 ...	11	1907 ...	13		

Barnstaple Rural. (*Population* 17,725.)

Year.	Cases.	Year.	Cases.	Year.	Cases	Year.	Cases.
1903 ...	3	1905 ...	4	1907 ...	2	1909 ...	4
1904 ...	1	1906 ...	6	1908 ...	1		

THE CARMARTHENSHIRE MUSSEL AND COCKLE BEDS.

(Map No. 23.)

This district, which extends along the south and west coasts of Wales from Worms Head to Cemmaes Head, embraces within its limits important areas over parts of which cockles and mussels are collected.

There are several estuaries on the south coast of Carmarthenshire wherein extensive tracts of sand are exposed at low water. This is notably the case in Burry Inlet, which extends between the Gower Peninsula and the mainland, *i.e.*, off Penclawdd, Llanelly, and Pembrey, as well as at the mouths of the Towy and Taf Rivers.

Mr. William Thomas, the Chief Fishery Officer for this district, has been good enough to assist me in marking upon Map No. 23, the approximate position of the several cockle and mussel areas.

The chief centres from which the cocklers set out are Laugharne, on the west, at the mouth of the Taf, Llanstephan, Ferryside, Llansaint, and St. Ishmaels, at the mouth of the Towy, and from Llanelly, Penclawdd, and Llanmorlais, in Burry Inlet.

The industry is almost entirely pursued by females, the males working in the adjoining coal mines or in some branch of the tin-plate industry; but during periods of trade depression or of strikes, a considerable number of men may be seen assisting the women in their labours.

The cocklers start from their homes, on the ebbing tide, walking across the sand in bare feet and short skirts, and accompanied by the donkeys, which are used to bear back the bags of shellfish. The work is of a severe nature, and involves in winter prolonged exposure to cold.

The cockle gatherers scrape the sand with what is practically a bent knife, or with a rake, carried in the right hand, while with the left hand the larger cockles are transferred to a riddle.

When this riddle is full, the cockles are riddled to separate the large from the small, and the large ones, after washing in a neighbouring pool of water, are transferred to a sack, which when full, and the day's gathering completed, is placed upon the back of one of the donkeys and the homeward journey commences.

Sometimes the women carry the smaller bags on their heads, or it may be that boats are used for bringing and taking back both the cockle gatherers and their spoil.

The general methods of dealing with the cockles at one or another parts of the district are as follows:—

(*a*) The cockles are despatched alive in their shells in sacks.
(*b*) The cockles are separated from their shells and the soft parts alone despatched.
(*c*) The separated cockles are salted with a view to preservation.
(*d*) The separated cockles are pickled in vinegar.

A brief description of the preparatory process, as practised at Penclawdd, a Flemish colony on the north coast of the Gower Peninsula, will alone be given:—

Along the foreshore hereabouts, there are to be seen numerous extemporised fireplaces, banked up with sand on three sides to protect them from wind and open in front. Upon these fires the cockles are placed, contained in a large iron or tin cauldron, a small quantity of water having been first poured into the saucepan to prevent scorching. As the cockles gape, owing to the passage of steam from below, the sea-water contained between their shells is liberated, and thus the cockles may be said to be literally boiled in their own liquor, this liquor being at the end of each boiling decanted almost entirely into another receptacle near, to be used subsequently for the process of washing the cockles, only a small quantity being retained in the cauldron for use as above explained.

The cockles are kept on the fire until the water is actually boiling, when they are emptied into another receptacle and a fresh batch of living cockles placed in the cauldron.

The boiled cockles are then riddled over a table, the soft parts passing through the sieve, the shells remaining behind.

From time to time the cockles are washed in their own liquor, and at the end of the process they are taken in a basket either to a neighbouring stream, to a spring, on to the foreshore, or to a pump or tap.

This fresh-water washing process is a very thorough one, in so far as I have witnessed it, its object being to rid the cockles of the sand which they naturally contain, and which imparts a gritty sensation to the teeth of the consumers.

At the end of a day's work at Penclawdd, there may be seen numerous cockle-wives sitting by the side of a rivulet which traverses the sands, awaiting their turn to wash their boiled cockles.

The cockles, when ready for market, are wrapped in white cloths, placed in baskets or small wooden tubs and taken to the neighbouring market towns by the cockle-wives, who may be seen in the early morning on the railway platforms with basket or tub deftly poised upon their heads.

On Saturdays a special train leaves Penclawdd for Swansea about 7 a.m., which is known as the "cockle-train," the cockle-wives bringing the cockles into Swansea by this train and returning by it in the evening.

As regards places such as Cardiff, Newport, Bristol, &c., I am informed by Dr. Morgan, the medical officer of health of Swansea, that women of 17 years old and upwards leave Penclawdd about Easter and act as the local-selling agents in these towns, the prepared cockles being forwarded to them from Penclawdd, to which place the cockle-sellers return about September, bringing with them as their savings some £30 to £60. In addition to this, Penclawdd has for the last four summers been visited by a wholesale agent, who purchases large quantities of uncooked cockles, which are sent in casks to America.

At Laugharne and some other places, if the cockles are intended for keeping, they are, after having been finally washed as described above, placed with cold water in the cauldron and allowed to remain on the fire until they "simmer," a process which is said to harden them and improve their keeping properties. The cockles are then heavily salted, *i.e.*, a bag of 28 lbs. is added to every 60 quarts of cockles. It is stated that thus prepared these cockles will "keep" for a fortnight.

Destination of the Cockles.

The cockles, either alive or boiled, find their way eventually to towns such as Cardiff, Swansea, Newport, Neath, Merthyr, Aberdare, Tredegar, Haverfordwest, Manchester, Bristol, Birmingham, Bath, Gloucester, Cheltenham, Swindon, and many other places, and they are despatched by train from St. Clears, Ferryside, Burry Port, and Penclawdd Stations as well as being hawked over neighbouring parts of South Wales in carts, fresh supplies of cockles being sent to meet the carts at different stations.

Number of Persons engaged in the Industry.

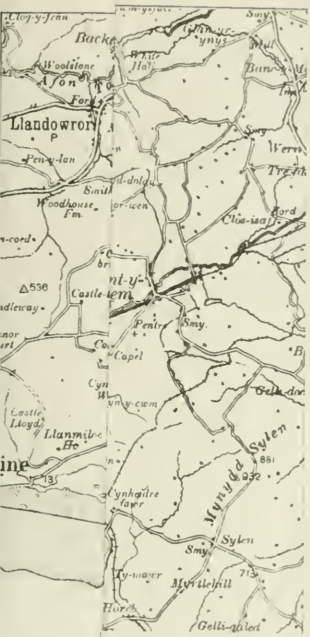
Captain Thomas, the Fishery Officer of the Milford Haven Sea Fisheries District, informs me that the approximate number of persons engaged in the industry at the several places above referred to is as follows:—

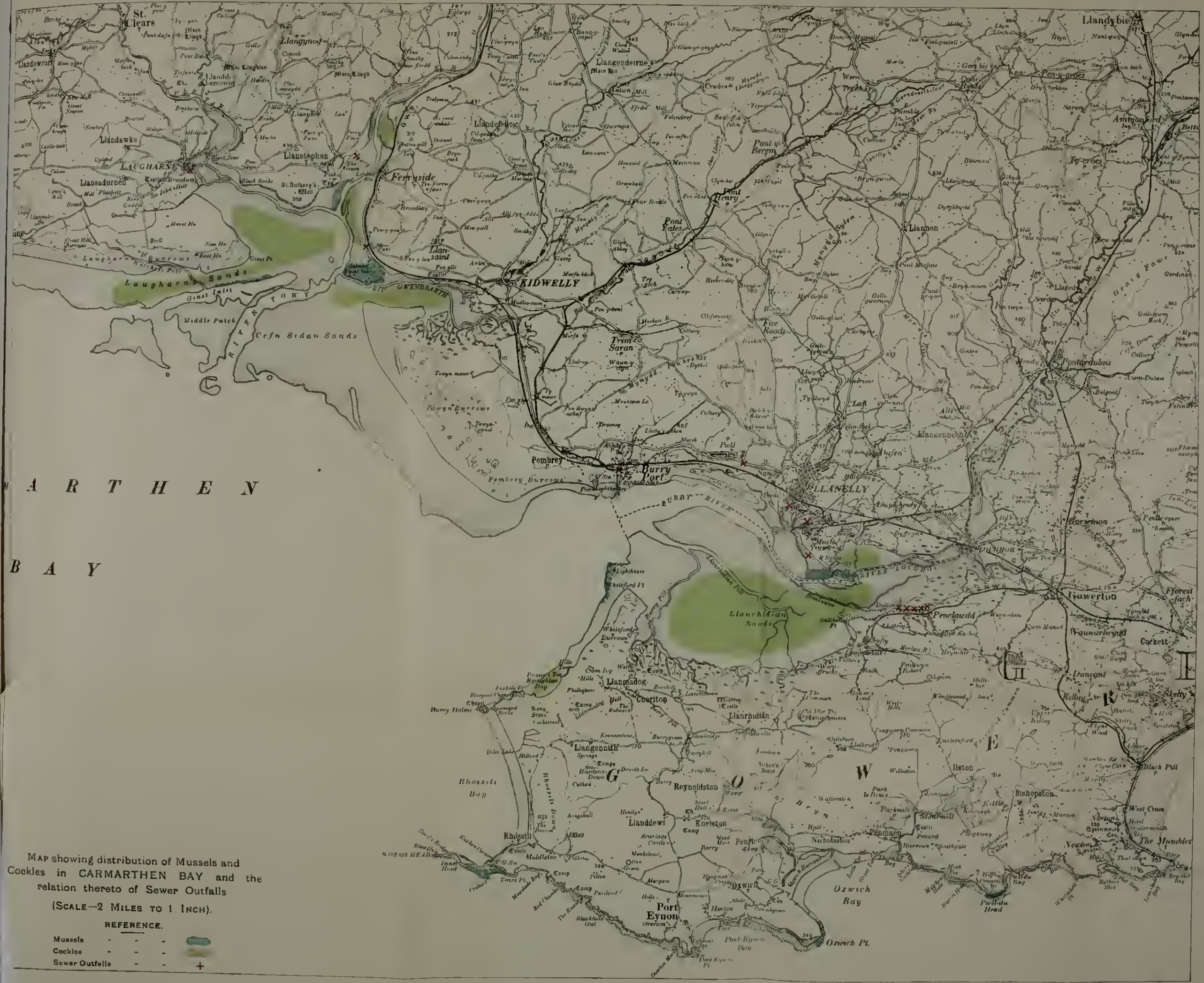
At Penclawdd and Llanmorlais, 250 persons are engaged at times either in cockle gathering or boiling on the Gower coast.

At Ferryside and Llansaint, about 150; at Laugharne, 50; at Llanstephan, 12; and at St. Ishmaels, about 50.

The cockles in a cooked condition are despatched at a rate of about 250 half-cwts. per week (12 cwts. of uncooked fish will make less than half-cwt. of cooked).

Some idea of the value of this industry may be gathered from the fact that the weekly sale of cockles brings to the cocklers about £300.


Cloy-y-frnn
Backe
Gilfach-yr-ynys
White Hall
Woodstone
Afon
Ford
Llandowror
P
Pen-y-lan
Smy
Wern
Tref
Smith
Woodhouse Fm.
Clos-isaf
Ford
-coed
Δ536
Castle
Penlre
Smy.
Capel
Gelli-dor
Castle Lloyd
Llanmiloe Ho
Mynydd Sylen
881
932
Cynheidre fawr
Sylen
Smy.
713
Ty-mawr
Myrtlehill
Horeb
Gelli-galed



MAP showing distribution of Mussels and Cockles in CARMARTHEN BAY and the relation thereto of Sewer Outfalls

(SCALE—2 MILES TO 1 INCH).

REFERENCE.

Mussels - - - 🟩

Cockles - - - 🟩

Sewer Outfalls - - +

Ordnance Survey Southampton 1910

The risks of Pollution to which the South Wales Cockles are liable.

An inspection of Map No. 23, will suffice to show that there are, upon the estuaries from which the cockles are collected, certain towns which discharge sewage either into the estuaries themselves or into the rivers which empty therein, and the approximate positions of the more important outfalls are indicated as before by means of red crosses.

Into the River Towy there discharges at Carmarthen itself, some eight miles from the nearest shellfish "beds," the sewage of a population of 10,000. Into Burry Inlet there discharges the sewage of Llanelly, with a population of some 27,000, and into the River Loughor, several miles inland, the slop water of Pontardulais (population, 3,000-4,000), and Llangennech, and into ditches, which subsequently reach the Burry Inlet, the slop water of Llwynhendy Cwmfelin, and halfway westward of Llanelly there discharges the slop water of Burry Port (population, 4,000).

In attempting to assess the danger from these several sources, it has to be recognised that the degree of dilution to which the sewage and slop water is, as a rule, subjected before it can reach the cockle beds is enormous, many of such beds being practically in the open sea.

So far as my observations have gone, I am inclined, *quâ* pollution, to attach most importance to the conditions under which the cockles are boiled and washed. As to this, I made detailed inquiry, both at Laugharne and Penclawdd.

At Penclawdd the cockles are not infrequently boiled in very undesirable places near to collections of ashes and other refuse, and, sometimes, to drains; and from what I saw during my visit to Penclawdd, there is urgent need for regulations as to this matter, since the cockle-wives do not seem to appreciate the need for proper cleanliness. The beach, in places hereabouts, presents collections of refuse, and, sometimes, I am informed, the contents of the privies are emptied on to the beach.

At Penclawdd the cockles, when boiled, are in several instances washed in streams which must be at times actually polluted, and which are at all times liable to pollution.

I was informed by the sanitary inspector, who accompanied me, that before certain coal mines were opened, there was a plentiful supply of pure water, but that since then this supply has much diminished, with the result that the cockles are now largely washed in the streams and springs which were used before the water supply was introduced, and some of which are, as has been said, obviously liable to specific pollution.

The most important washing centre is a spring situated on the foreshore towards the east end of the village, and within a few yards of this spring, and nearer to the sea than it, there is the outlet of a large iron pipe carrying down a considerable quantity of slop water and other filth. This filth immediately enters the stream which is formed by the spring in which the cockles are washed, and the pollutions which thus enter it must, near high tide, be forced up the stream to the spring itself, a very few yards distant from the outlet of the iron pipe.

I pointed out to the sanitary inspector who accompanied me the serious risks which threatened the cockles, and he undertook to bring the matter before the district council, with a view of having definite places allotted both for the boiling and the washing of the cockles.

He informed me that a new water supply was in contemplation, and that, when this had been procured, there would be no difficulty in obtaining an abundance of pure water wherein to cleanse the cockles.

This matter, as also the regulations referred to, is one of urgency.

At Laugharne, the water in which the cockles are washed is not free from the risks of pollution, and here, as at Penclawdd, a fresh supply is, I am told, under consideration.

There is undoubted need in this South Wales cockle area for regulations defining the places at which cockles may be washed, and areas near to sewer outfalls where such shellfish may not be collected. It is also necessary that arrangements should be made for duly enforcing the regulations.

In connection with the cockle industry at Penclawdd, I have to acknowledge the assistance of Dr. William Williams, the county medical officer of Glamorganshire, of Dr. D. J. Morgan, medical officer of health of Swansea (who sent me an excellent account of the industry), of Mr. Ind, the Clerk, and Mr. G. A. Jones, the sanitary inspector of the Gower Rural District.

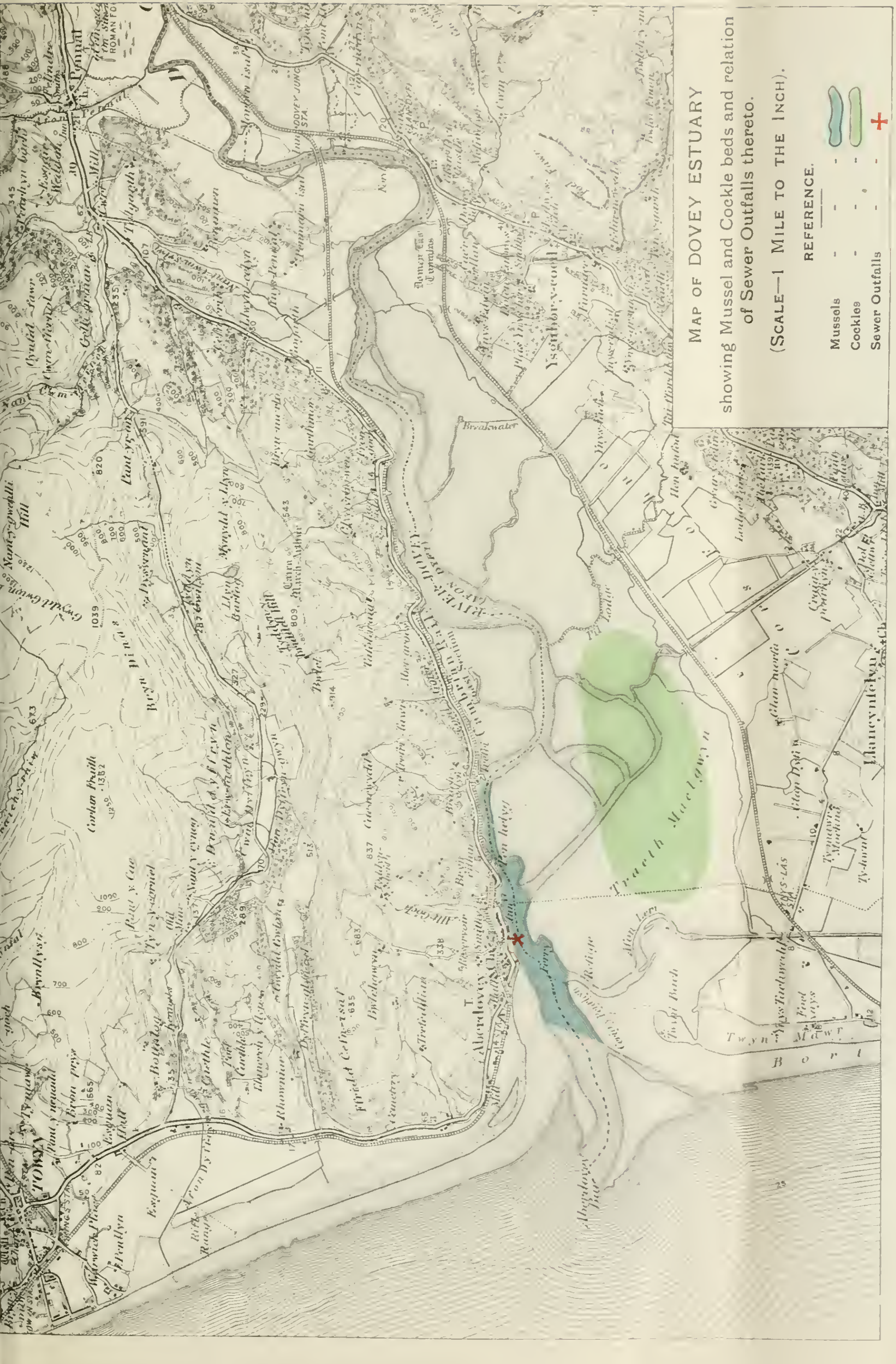
Epidemiological Evidence.

The medical officers of health of Llanelly Urban and Rural Districts (joint population, 51,000), of Carmarthen Urban and Rural Districts (joint population, 33,799), of Burry Port Urban District (population, 4,000), and of the Gower Rural District (population, 7,266), in parts of one another of which districts the cockle gatherers reside, and in which, I am informed, large quantities of cockles are consumed, have seen no reason to ascribe any of their enteric fever to shellfish.

Dr. Morgan, medical officer of health of Swansea, tells me that Swansea is supplied with cockles and mussels mainly from the village of Penclawdd, while small quantities come from the neighbouring villages of Llanmorlais and Crofty, and a few are gathered from the Swansea sands. He has also furnished me with a table, which will be found on page 83, showing the number of cases of enteric fever in which cockles and mussels (as well as oysters) were partaken of within the incubation period of enteric fever.

THE ABERDOVEY MUSSEL FISHERY. (Map No. 24.)

The mussels in the Aberdovey estuary extend, as shown upon the accompanying map (No. 24), from a point opposite Aberdovey station seawards, almost up to the house marked Trefri landwards, and mussels are, at times, dredged for over the whole of this area and despatched direct to market for human consumption. There are about 12 boats engaged in the industry.



MAP OF DOVEY ESTUARY
showing Mussel and Cockle beds and relation of Sewer Outfalls thereto.
(SCALE—1 MILE TO THE INCH).

REFERENCE.

Mussels - - - 🟦
Cockles - - - 🟩
Sewer Outfalls - - +

Ordnance Survey, Southampton, 1910.

The most valuable mussels are found over the inland portion of this area, those to the seaward being frequently not in a marketable condition. But these seaward mussels, when transplanted to the upper portion of the landward area take on growth at a very rapid rate and become marketable in a few months.

The main channel in which the mussels are found is a deep one, and rakes with handles some 30 feet long are needed to procure them. Even at low water of spring-tides the mussels are well covered.

The mussels from this area are despatched to Manchester, Birmingham, Oldham, Bolton, Leeds and certain other large towns, the prices obtained being about 5*s.* for a bag containing a little over one cwt. The amounts despatched recently are shown below:—

Months.	*Bags.*	*Value.* £
October, 1906 ...	635 ...	91
November ,, ...	1,016 ...	104
December ,, ...	176 ...	29
January, 1907 ...	95 ...	14
February ,, ...	46 ...	7
March ,, ...	16 ...	2
	1,984	£247

In 1906, owing to the fact that the market was over-supplied, the value of the mussels fell temporarily to about 2*s.* per bag.

The Aberdovey Cockle Industry.

There are, I am told, no cockles exported to England from the Dovey River; but over the sands to the south of the estuary in the position indicated on map No. 24, cockles are collected and sold locally, a large number going, it appears, to Aberystwyth. The amounts in value are given below:—

Month.	*Bags.*	*Value.* £
November, 1906	34 ...	7
January, 1907	40 ...	6
February ,, ...	40 ...	6
March ,, ...	41 ...	6
April ,, ...	60 ...	9
May ,, ...	70 ...	10
June ,, ...	65 ...	9
July ,, ...	70 ...	10
August ,, ...	80 ...	12
September ,, ...	70 ...	10
October ,, ...	59 ...	9
November ,, ...	56 ...	8
December ,, ...	40 ...	6
	725	£108

The Pollutions entering the Dovey Estuary.

At high tide this estuary presents an enormous expanse of water, measuring nearly two miles in width and, as will be seen by the map, Aberdovey itself is the only aggregation of population upon its banks.

The sewage of Aberdovey, which has a population of about 1,200, is all intercepted from the beach and discharged by one main 15-inch cast iron outfall, near the chief hotel. The pipe is carried well out into the channel, and even at low water of spring tides the outfall is, I am assured, covered by about 3 feet of water. The sewage is discharged for half-an-hour at half flood, being held up by a penstock for the remaining 11½ hours. The surveyor informs me that it was found that by liberating the sewage at the time indicated it is carried to within about 100 yards of the south side of the river and then straight out to sea.

At the time of my visit, which was near low water of a neap tide, it was not possible to determine by the presence of any sewage or discolouration, the precise position of the outfall.

It must certainly be said that, if the arrangement described by the surveyor is faithfully adhered to, and the currents are as described, the risk to the mussels in the estuary is but small, although it must still be regarded as dangerous to dredge for mussels in the vicinity of an outfall.

Such risk as does actually obtain might be materially reduced by the compulsory transplantation of the mussels seaward of the sewer to a position considerably landward of it, *i.e.*, landward of the lifeboat house; and such transplanting would probably prove a lucrative undertaking since the mussels gathered seaward of the Bar are seldom marketable until after they have been relaid.

I did not see the process of mussel gathering at Aberdovey, owing to the fact that in this estuary the season does not commence until the beginning of November.

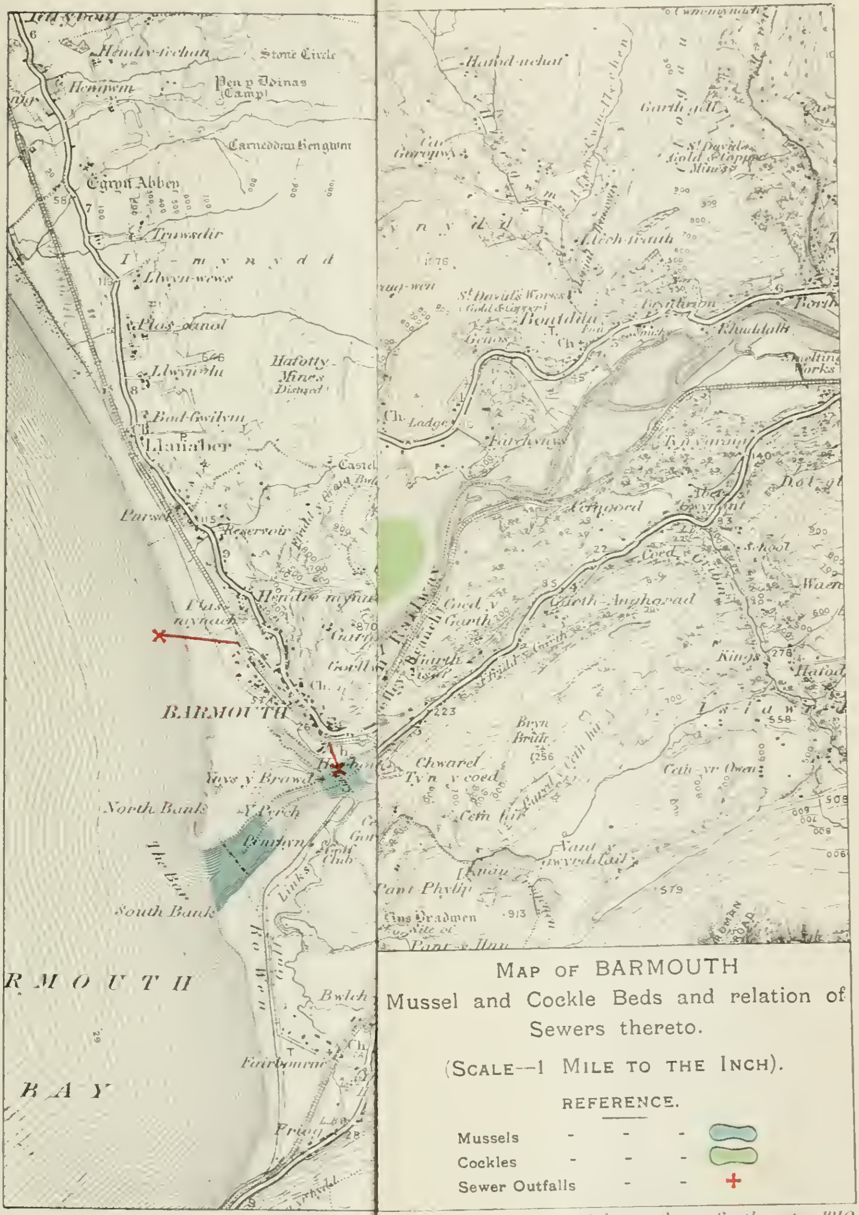
THE MUSSEL INDUSTRY OF THE BARMOUTH ESTUARY. (Map No. 25.)

The Barmouth mussels extend along this estuary from the Clock House landward to the island near the Ferry seaward, and they are also to be found on the southern shore alongside the bridge (see map) as well as near the Black Rock above the bridge near the south side. About 15 boats are employed in the work.

Mussels, for the most part unmarketable, may also be dredged up near the Bar (see map). Seaward of the bridge the mussels can, as a general rule, only be secured by dredging with long rakes, but, landward of the bridge, there is at low spring tides some handpicking.

Dredging for mussels takes place every year from November to March (inclusive) landward of the bridge, but only once every three years seaward of the bridge.

MAP No. 25.



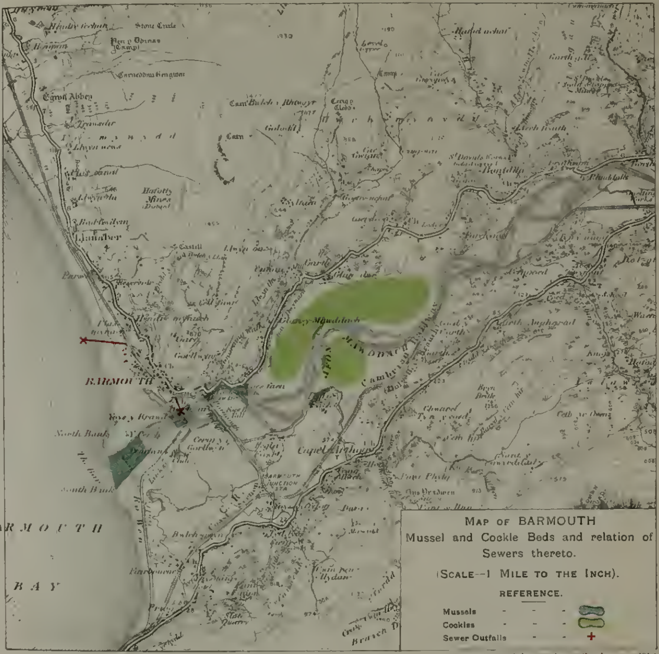
Map of BARMOUTH
Mussel and Cockle Beds and relation of Sewers thereto.
(Scale—1 Mile to the Inch).

REFERENCE.

Mussels - - - 🟦
Cockles - - - 🟩
Sewer Outfalls - - +

Ordnance Survey, Southampton, 1910.

MAP No. 25.



MAP OF BARMOUTH
Mussel and Cockle Beds and relation of Sewers thereto.
(SCALE—1 MILE TO THE INCH).

REFERENCE.

Mussels - - - 🟦
Cockles - - - 🟩
Sewer Outfalls - - +

Ordnance Survey Southampton, 1910.

The destinations of these Barmouth mussels are mainly Manchester and Birmingham, and the amounts despatched have been as follows:—

Month.	*Bags.*	*Value.*
		£
November, 1906	153	38
December ,,	233	58
January, 1907	202	50
February ,,	10	2
	598	£148

There are, it is estimated by Captain Davis, the Fishery Officer of the district, sometimes as many as 15 boats, containing one man each, engaged in mussel dredging, and Captain Pritchard, in whose district the Barmouth estuary was formerly included, reports that the increase in mussels landed in 1907 is largely due to the fact that the dredgermen were persuaded to carefully sift the immature mussels from the mature, and to relay these former in localities in which they were likely to grow rapidly.

THE COCKLE INDUSTRY OF THE BARMOUTH ESTUARY. (Map No. 25.)

In former years there appears to have been an extensive cockle industry in this estuary, over the area coloured green on map No. 25, but at the present time there is practically no trade in these molluscs, a few gatherers being perhaps seen occasionally who dispose of their cockles locally.

The Pollutions of the Barmouth Estuary.

The sewage of Barmouth with a population, the surveyor tells me, of about 2,500 in winter and 6,000 in summer, discharges its sewage untreated by means of two separate outfalls in the positions indicated on the map, *i.e.*, one well out to sea at the north of the town, the other into the estuary near the ferry. Each outfall discharges well below low water mark, there being at the lowest water of spring tides some 10 feet of water over the northern outfall, and about 6 feet over the southern or estuary outfall.

Each outfall discharges the sewage of about half the population in an untreated condition. In addition to these two outfalls, there are five or six houses landward of the bridge which discharge their drainage to the estuary, these houses being, it seems, too low to be drained into the town sewer.

It is clear that there is great danger from the consumption of mussels dredged up from the vicinity of the estuary outfall, and if the Barmouth mussels are to be rendered relatively safe for immediate human consumption, it is necessary that the sewage which now enters the estuary should be intercepted and carried out to sea separately or pumped, if practicable, into the other outfall.

Pending amendment in this sense, the four drains seaward of the bridge should be taken out of the estuary, and all dredging or handpicking of mussels seaward of the bridge prohibited, unless, of course, for the purpose of relaying landward of the bridge. There has, I understand, been some relaying in this sense, and the results as regards the mussels have been decidedly encouraging.

THE PORTMADOC MUSSEL INDUSTRY.

(Map No. 26.)

The mussel beds hereabouts extend at intervals along the bed of the estuary from a short distance above the bridge to about half-a-mile below Borth, *i.e.*, to Gareg Goch.

They also extend along a channel running beneath the New Wharf northward of the Ballast Bank.

Over practically the whole of this area mussels are raked for from boats, and in places at low water picked by hand.

When gathered they are taken to the harbour, where they are picked over to separate the marketable mussels, packed in bags, washed with harbour water and despatched by the narrow-gauge railway to Festiniog, where they are sent to their destination by the Great Western Railway.

There are about nine boats now engaged in the industry, most of the boats carrying one man, but some two. The number of handpickers varies considerably. It is said, that at low spring tides, when many of the mussels ebb dry, there may be over 30 handpickers. During the season 25*s.* to 30*s.* per week may be easily made.

The Portmadoc mussels are well-fished and they procure in the market about 4*s.* 6*d.* a bag of one cwt. One dredger may obtain 1½ to 2 bags per tide.

The best and largest mussels are, it is said, procured opposite and below Borth, and at the date of my visit dredging was taking place in practically all parts of the channel from the lock above Portmadoc bridge to Gareg Goch, at which latter place I saw two men raking for mussels near the rocks.

The mussels are sent mainly to Birmingham, but a few go to Manchester, and the amounts sent away have been furnished to me by Captain Pritchard, the Fishery Officer of the District. A few of the mussels are sold locally.

Month.	1895.		1906.		1907.	
	Cwts.	Value.	Cwts.	Value.	Cwts.	Value.
		£		£		£
January ...	50	10	40	8	83	18
February ...	32	7	100	24	50	12
March ...	20	5	40	10	20	5
September...	215	53	540	115	620	124
October ...	168	42	460	92	592	107
November...	230	54	232	54	420	84
December ...	468	117	154	27	254	50
	1,183	288	1,566	330	2,039	400

and Cockle

r Outfalls thereto.

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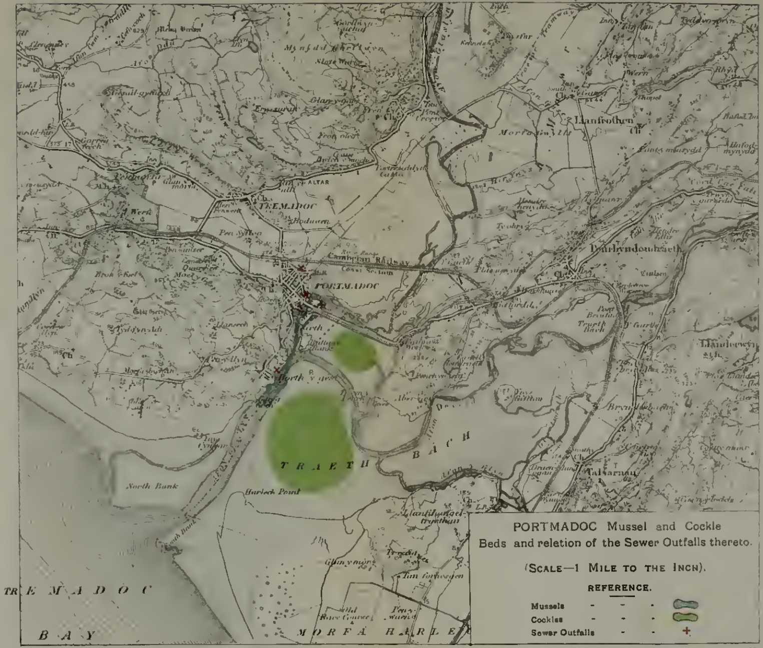
rvey. Southampton. 1910.

MAP NO. 26.



PORTMADOC Mussel and Cockle Beds and reletion of the Sewer Outfalls thereto.

(SCALE—1 MILE TO THE INCH).

Ordnance Survey, Southampton, 1910

MAP NO. 26.

The Portmadoc Cockle Industry.

This industry was formerly much more extensive than is the case at the present time, and such cockles as are gathered are collected from the area coloured green on map No. 26. They are disposed of locally.

I saw none being collected at the date of my visit. The local Fishery Officer tells me that about 20 cwts. are collected monthly, their value being about £4 10*s*.

The Pollution of the Estuary.

The drainage of the town of Portmadoc, with a population of some 3,400, enters the estuary untreated through several separate outfalls.

The main source of discharge is the Chapel Street sewer, which takes the sewage from some 2,000 persons. This discharges into a small stream which after a short run enters the estuary near the gas works, and into this same small stream, at a distance of about a mile northward of Portmadoc, *i.e.*, at Tremadoc, there discharges the effluent from two septic tanks, serving a population of about 120.

On entering the estuary, the stream carrying this sewage undergoes dilution by admixture with the waters of the River Glaslyn coming down from the Welsh mountains.

Into the estuary itself there are four separate sewers discharging as well as a drain from the Festiniog railway station.

The first of these sewers, beginning from the north, discharges from Britannia Terrace and enters the estuary on the landward side of the dock-gates, which have been constructed to keep back the tidal water from the uplands. This sewer drains a population of about 210. Seaward of the lock, and on the Portmadoc side above the bridge is another outfall, which takes the drainage from some 200 people in and around Smith Street. Seaward of the bridge and on the western side, near the dock, is a sewer draining a population of about 380, and on the opposite side of the river a pipe, which, I am informed, drains the railway station.

Seaward of these outfalls, there is no other until Borth is reached, about three-quarters of a mile lower down the stream, and here a pipe draining a population of approximately 600 persons enters, what at low water is a sort of pool on the beach. Originally this outfall discharged well out into the channel, but the shifting of this channel has left the outfall on the sand well above low water mark. A septic tank is now being constructed hereabouts, and the sewage will, when the tank is completed, only be liberated at certain states of the tide.

There is no possibility of dredging for mussels in the immediate vicinity of the main outfall, but I saw dredging at about low water time dangerously near the entrance of the stream which carries down the sewage from the main outfall, and this stream at the time of my visit was also in danger of being polluted by the escape of gas liquor from the gas works.

I also saw mussels being dredged for dangerously near two of the other Portmadoc sewers.

While the Portmadoc outlets are in their present positions, there is, obviously, danger from the consumption of raw or imperfectly cooked mussels collected anywhere near the sewer outfalls, and although the topographical conditions at Borth are at present such as to render the risks of pollution thereabouts materially less than at Portmadoc, it is clearly desirable in the interests of the mussel industry to intercept the Portmadoc and Borth sewage and to discharge it all on the ebb tide only well seawards of Borth.

Failing the practicability of interception in the above sense, there would be a diminution of risk by prohibiting the collection of mussels in the neighbourhood of Portmadoc, and by transplant-the Portmadoc mussels into the deep and wide channel below Borth.

As regards cockles, the risk is, it appears to me, remote, seeing that no sewage can reach them directly, and that they are only covered with water on the rising tide when there is an enormous volume of water.

THE PWLLHELI MUSSEL AND COCKLE BEDS.

These, I am informed, are situated outside the harbour—"Gamlas," a little to the east of Carreg Defaid. The mussels are handpicked at low spring tides and sold locally.

Cockles are collected a little to the eastward of the harbour mouth, and are merely sold locally.

The sewage is liberated untreated by two outfalls—one on either side of the mouth of the harbour.

The risk to the mussels on "Gamlas" would appear to be very remote, but it is possible that, on the flowing tide, some very dilute sewage might be carried over the cockle area.

THE COCKLE BEDS OF THE ISLE OF ANGLESEY.

(Map No. 27.)

There are two large expanses of sand upon the Anglesey coasts where cockles are gathered—on Malldraeth Sands on the south, and at Redwharf Bay on the north.

On Malldraeth Sands on October 20th, 1908, there were eight cocklers at work with one cart. The cockles, when collected, are, I am informed, washed in holes in the sand and brought back to Malldraeth village, from which place they are hawked about in parts of Anglesey.

A small slop-water drain enters the Cefni River at Malldraeth, and into the same river, but some eight miles from its mouth, the sewage of Llangefni, with a population of about 2,000, discharges.

Assuming that no cockles are washed in the water of the river itself, there would not appear to be danger of the specific pollution of the Malldraeth cockles.

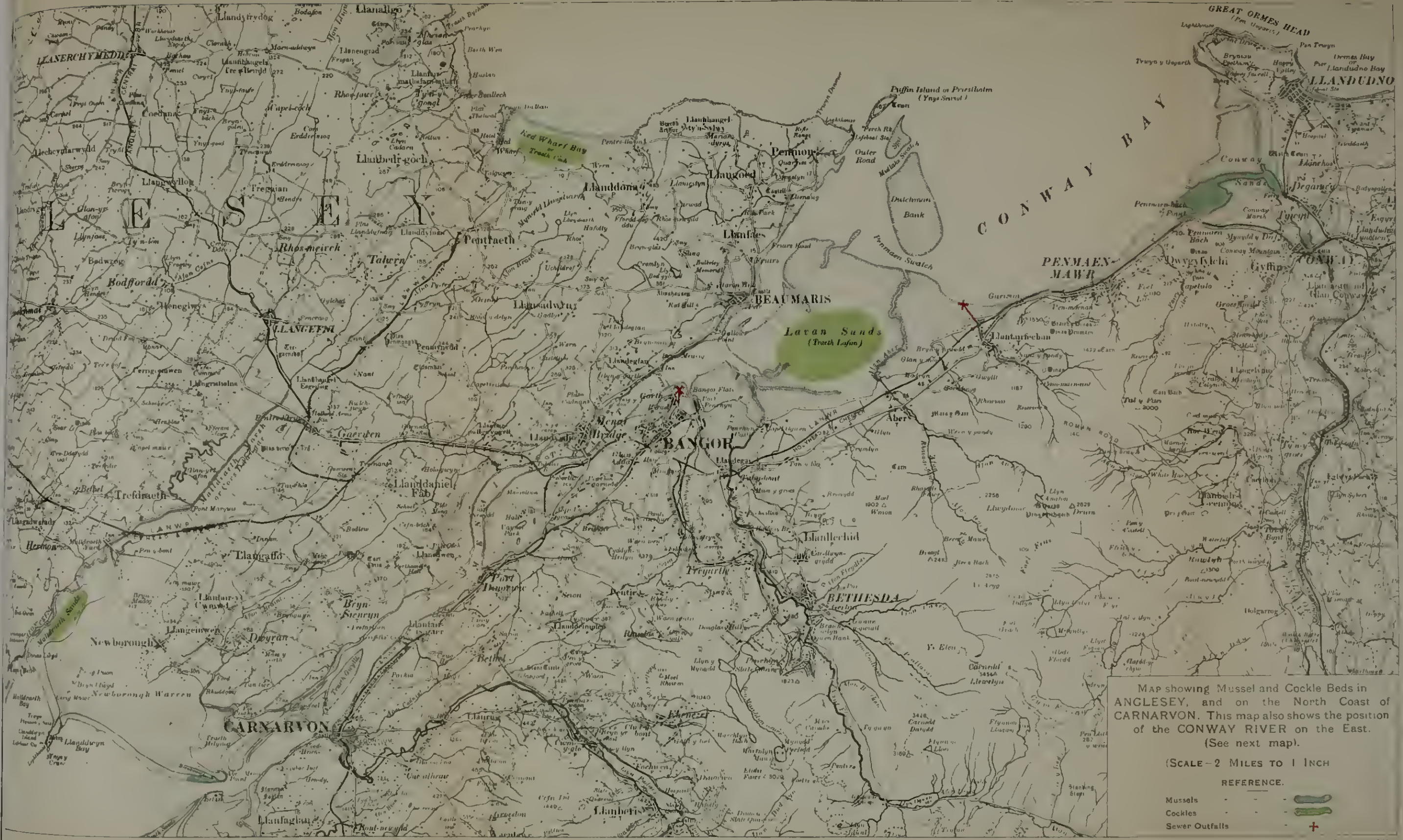
THE REDWHARF BAY COCKLES.

(Map No. 27.)

This bay consists of a large expanse of sand on the north-eastern shores of Anglesey, the cockles from which are gathered from the east of the stream traversing the sands.

About 12 persons are engaged in the trade, and the cockles are sold in Anglesey.

LLANERCHYMEL
Chwaen-gwyn
Pandy
Glan-y-gors
Carmel
Prys Owen
Ty Croes
Llechcynfarwydd
Sherry
Trefor
Llandrygarn
Glan-yr-afon
Llynfaes
Pandy Treban
Cegir-mawr
Bodwr
Llyn Hendref
Gwalchmai
Llanbeulan
Cefn-du
Gaerwen
Tal-y-llyn
Soar
Dinas
Plas-bach
Tre-Ddafydd-isaf
Ty-mawr
Bethel
Bodorgan
Llyn Coron
Llangadwaladr
Hermon
Malltraeth Yard
Kennels
Bod-Owen
Cwningar Bodowen
AFON CEFNI
Malltraeth Sands
Dinas Lwyd
Malltraeth Bay
Trwyn Ffynnon y Sais
Llanddwyn Island
Lifeboat Sta
Lighthouse
Ynys y Cranc
Llanddwyn Bay
Cerig Mawr
Bryn Llwyd
Trwyn Dinmor
Lighthouse
Perch Rk
Lifeboat Sta
Outer Road
Puffin
Penmaen
Sands
(Traeth Lafan)
Afon Aber
L.&N.W.R.
CHESTER
Glyn
Crymlyn
Moel Wnion
1902
Bronydd
Llanllechid
Afon Ffrydlas
Parc
BETHESDA
Gerlan
Braich-melyn
Gwaun-y-gwiail
Afon Caseg
Afon Berthen
Ty-gwyn
Pentre
Llyn Idwal



Map showing Mussel and Cockle Beds in ANGLESEY, and on the North Coast of CARNARVON. This map also shows the position of the CONWAY RIVER on the East. (See next map).

(Scale – 2 Miles to 1 Inch

REFERENCE.

Mussels - - - 🟦
Cockles - - - 🟩
Sewer Outfalls - +

Ordnance Survey, Southampton 1910

The risk of any specific contamination of the cockles hereabouts would appear to be very remote, but it would be well to avoid washing the shellfish in the stream coming down from the neighbouring village. I understood that all washing was carried out in holes made in the sand or in pools left by the receding tide.

THE BANGOR MUSSEL BEDS. (Map No. 27.)

This is of small proportions, and consists for the most part of the collection of mussels from the outside of the fish weir, which was constructed many years ago on the Bangor Flats in the position indicated on Map No. 27.

This weir consists of upright posts or supports, between which branches are woven longitudinally, and it is on the more seaward portion of this weir that the mussels are found attached, the best mussels being those on the lower portion of the weir, which are covered with water for the longest period. Although mussels grow upon the upper portions of the weir, such mussels are small, owing to the fact that they are deprived of food for many hours each tide.

There are, I understand, five persons at Bangor, who habitually collect mussels from this weir, and at times there may be many persons thus engaged.

The mussels, after separation and washing in the adjacent water, are despatched to Liverpool. Captain Jones has seen 20 bags despatched in one week, but never more than this.

The main Bangor sewer, which serves a population of about 10,500, discharges its sewage untreated, and at all states of the tide, into the Menai Straits in the position shown on the map.

The tidal conditions in the Menai Straits hereabouts are peculiar. The tides meet and separate a short distance seaward of the outfall, *i.e.*, towards Beaumaris, and consequently on the ebbing tide the Bangor sewage is carried southwards down the Menai Straits, while on the flood it is carried to the north, where it meets the tide coming from the north. The waters here mingle together, and it is only after enormous dilution, if at all, that the Bangor sewage could reach the weir to which the mussels are attached.

THE LAVAN SANDS COCKLE INDUSTRY. (Map No. 27.)

Cockles are collected over a large area on the Lavan Sands, and despatched by rail from Aber and Llanfairfechan stations.

The industry, although considerable, is by no means so extensive as in former times, in consequence, largely, I am told, to delay in transmission of the shellfish to the markets. But this defect has now been remedied.

The Lavan Sands are practically in the open sea, and are but rarely exposed to the liability of pollution.

To the west the nearest sewer, that of Bangor, is about two miles distant, while to the east, that of Llanfairfechan, is about a mile from the nearest cockle ground. I am informed that no cockles are gathered eastward of the Aber River, which at low water traverses the sands in the direction indicated on the map.

There were but few persons at work on the sands at the date of my visit, but the Fishery Officer tells me that he has seen 40 bags sent off by rail from Aber station to Manchester and other towns, and he has seen 35-40 persons gathering mussels at one time.

At Llanfairfechan mussels were formerly collected from the large sewer pipe, but the district council have now agreed to keep the pipe free from marketable mussels.

THE CONWAY MUSSEL INDUSTRY. (Map No. 28.)

This is one of the most important mussel industries in the country, and large supplies of mussels are sent daily from Conway station to the Lancashire and Midland towns.

Some idea of the amount despatched may be gathered by the returns for Saturday, October 17th, 1908, which were procured for me from the railway station by Captain Jones, the Fishery Officer of this part of the Lancashire and Western Sea Fisheries District. It should be stated that Saturday is probably the heaviest day of the week as regards despatch of shellfish:

Manchester	82 bags.
Halifax	65 ,,
Warrington	23 ,,
Nottingham	22 ,,
Huddersfield	20 ,,
Bolton	12 ,,
Elland	9 ,,
Birmingham	8 ,,
Leeds	8 ,,
Sheffield	7 ,,
Brighouse	6 ,,
	262 bags or cwts.

The figures for the year 1906, which are contained in Mr. Johnstone's report on the examination of the Conway mussel beds, may also be given.

Month.	*Amount.* *Cwts.*	*Value.* £
January	2,520 ...	302½
February	1,948 ...	234
March	1,267 ...	137
April to August ...	Close season.	
September	3,800 ...	570
October	5,820 ...	730
	15,355	£1,973½

In so far as the district of Conway is concerned, it is estimated that there are from 250-300 persons entirely dependent upon the mussel industry from September to March inclusive, during the close season, the mussel gatherers being engaged in pursuits connected with the numerous tourists who visit this part of North Wales

It may be mentioned, that on Friday, October 23rd, 1908, when I was accompanied by Dr. Travis, the medical officer of health of Conway, and Captain Jones, we counted from 70 to 80 persons hand-picking mussels on the "scalps" uncovered at low tide, and between 40 and 50 boats, raking for mussels in one or another portion of the channel.

The mussel fishery extends, at intervals, over some three miles of the estuary, reaching landward nearly up to Glan Conway, and seaward to Penmaendach Point (see map No. 28). Over the whole of this area mussels are at times raked for, although it is only occasionally that raking takes place immediately opposite the town of Conway, there being, it appears, but few mussels thereabout.

So deep is the channel in many places, that rakes with handles as much as 49 feet long have to be used, and even at just low water of spring tides very long handles are necessary.

Handpicking may take place at low spring tides in several places along the mussel area, but, for the most part, this handpicking is confined to the extensive mussel beds near the mouth of the river, as shown on the accompanying map: thereabouts large areas of mussel beds are exposed at every low tide, the area at low water of spring tides being very extensive. Over this area the mussels are picked by gatherers from Conway, Deganwy and Llandudno, the large mussels being duly separated from the small on the spot, washed in wicker baskets in the neighbouring waters, packed in bags and despatched from Conway Station.

In the case of the raked mussels, the procedure is somewhat, and in a sense very materially, different.

When the actual head of the rake is raised by the long handles to the level of the boat, the dredgerman throws back into the water any large stones or other debris which are not actually attached to the mussels, but he transfers to the boat a miscellaneous assortment of large and small mussels together with stones and other small objects, to which the shellfish are attached. When the flowing tide commences, the boats return to Conway, where the separation of the large from the small mussels, and from the stones, takes place, and the marketable mussels, after being washed in the water alongside the boats, are packed in bags, labelled and despatched by train to their destination. The separation of the mussels is a somewhat laborious process, and it is not an uncommon practice for the gatherers, on arrival at Conway, to repair at once to their homes for a meal, leaving the picking-over process to be done subsequently. The debris from the process of preparation for market is left in the boats and returned next day to the mussel beds, it being obviously important to restore the immature mussels to the estuary for futher growth.

This return of smaller mussels to the estuary is in accordance with the terms of the following bye-law of the Lancashire and Western Sea Fisheries Committee, upon which, in this instance, I understand that a somewhat liberal interpretation is placed:—

> 22. Any person who takes any shellfish the removal of which from a fishery is prohibited by any of these bye-laws or the possession of which is prohibited by any Act of Parliament shall forthwith re-deposit the same as nearly as possible in the places from which they were taken or, under the written authority of the Superintendent, on other suitable ground . . . .

The Pollution of the Conway Estuary.

The River Conway, which drains an extensive area of mountainous country, is formed by the confluence of the Rivers Lledr and Machno, the former of which rises in the hills to the west of Moel Siabol, the other in the hills well to the south of Bettws-y-Coed. These two streams unite into one at Fairy Glen, and this, after passing Bettws-y-Coed, is joined from the west by the Lingwy, a large river coming down from beyond Capel Curig, near which place it receives a tributary taking its origin from above Pen-y-Gwryd. On passing Bettws-y-Coed, the Conway River, after a run of another three miles, traverses Llanrwst, and, a short distance further on, near Trefriw, it becomes tidal at a point some nine miles from Conway Bridge.

At Bettws-y-Coed a population of some 500 drains into the river, and lower down the towns of Llanrwst (population 2,650) and Trefriw (800) drain therein by means of 12-inch earthenware pipes.

Subsequently, until Conway is reached, the pollutions are small.

In the vicinity of Conway, the sewage of Conway itself, of Llandudno Junction, and of Deganwy enter the river, and it may be well to describe each outfall separately, beginning with those at Glan Conway a little landward of Llandudno Junction.

Here, at Glan Conway, are two outfalls discharging on to the foreshore in the positions indicated on the map. These are 9-inch pipes; one draining a population of 90 and the other a population of 80. Both these outfalls discharge well above low water mark, and some deposition of solids takes place before the sewage reaches the channel on the ebb tide.

Further to the north is the Llandudno Junction sewer, which takes the drainage from a population of 550 in the urban district and 700 in the adjoining rural district, *i.e.*, 1,250 in all.

This is a 12-inch sewer which discharges high up on the foreshore, about 300 yards above low water mark, into a rivulet which carries it at low water to the channel alongside the suspension bridge.

Almost opposite the point of entry of this rivulet to the channel, and on the Conway side, is another 12-inch sewer draining a population of about 600, the outlet of sewer being only uncovered at low water of spring tides. It was uncovered on Friday, October 23rd, 1909, when there was a tide of nearly 16 feet.

Seaward of this outfall and on the same side of the river is a 9-inch sewer, for a population of 40 (also uncovered on a 16 feet tide), and a little beyond this, *i.e.*, seaward, is the main outfall, a 12-inch pipe taking the drainage of a population of 2,550 people, there being again a short distance seaward of this a 9-inch iron pipe draining a population of 10 persons. Both these outfalls were uncovered on the date of my last inspection.

Some distance seaward of this and discharging high up into a stream traversing the shores of the estuary are two outfalls from populations of 620 and 70 respectively.

At Tywyn, opposite Conway, is a 15-inch pipe taking the drainage from a population of 700 and discharging relatively high up on the beach. The sewage from this outfall, except when the foreshore is covered by the tide, enters a rivulet which, turning towards the west, joins the low-tide channel alongside the quay.* At Deganwy, further seaward, is a 15-inch pipe discharging the sewage from 900 people.

The sewage of Llandudno, with a winter population of about 11,000, and a summer population of about 35,000, is discharged untreated in the position indicated on the map, *i.e.*, at a point 1,495 yards in a W.N.W. direction from the shore. The outfall is ebb dry at low water of spring tides, but there is a dip pipe at the sea end which is always submerged. At high water of spring tides the end of the sewer is covered by fully 24 feet of water.

At spring tides the discharge commences at about 2¼ hours after high water, and continues until 3¼ hours before the next high water. At neap tides the discharge commences about 2½ hours after high water, and continues until 3¼ hours before the next high water. In the intervals between discharge the sewage is stored in a sewer measuring 6 feet by 4 feet.

From the records of flood experiments made near the outfall, and which were shown to me at Llandudno by Mr. W. T. Ward, the Deputy Engineer, it would appear that under the above conditions of discharge no sewage is likely to reach the mussel beds or to be carried into the Conway River.

The Conway estuary, from Glan Conway seawards, presents at high tide a broad expanse, or lake, of water which has been cut into two parts by the London and North-Western Railway embankment, the effect of which has been to drive all the water entering and leaving the estuary with each tide through the channel beneath the bridge. Even at quite low water of spring tides there is in the centre of the main channel a strong current, the effect of which is to rapidly dilute and diffuse the pollutions entering it, and to scour out the channel itself, on the banks of which at low tide it is possible to walk quite to the water's edge on firm, relatively clean, ground. But at places on the flats, left dry at low tide, there are deposits of mud which render walking a difficult matter. On these banks, however, there are no mussels.

In the channel itself there are set up at places near the sides little eddies or backwaters, which have the effect of inducing the sewage near certain of the sewers to cling to the bank, and this phenomenon is especially manifest near the main Conway sewer and near the entrance of the Llandudno Junction sewer to the main channel near the railway bridge, the sewage tending to collect at certain conditions of tide into a pool, which has the effect of discolouring the water for some distance around, and in the channel opposite this pond it is a common practice to dredge for mussels. I saw, too, on the occasion of one of my visits, a girl handpicking mussels dangerously near to the collection of sewage referred to. It is true that in the channel hereabouts there is a great depth of water even at low tide, but this fact does not render it safe to collect mussels in this locality.

As things are at present there is no byelaw or power to prohibit the dredging for mussels in the vicinity of the Conway sewers, and until the sewers are removed or the fishermen prohibited from dredging near them, the danger is obviously a serious one.

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* This pipe has since been extended.

As, however, the largest amount of the dredging is carried out near the mouth of the river, it would seem a reasonable step to take to prevent boats from dredging near the outfall. So, too, with regard to handpicking, there should be similar restrictions.

The Washing of the Mussels.

On the "scalps," near the mouth of the estuary, it is the custom of the handpickers to wash the mussels on the spot, and to pack them at once in the bags preparatory to despatch to market. But in the case of the dredgermen, it is, as has already been pointed out, the general custom to pick over the mussels and to wash them prior to packing at Conway itself, and, unfortunately, the most convenient spot is near the town, in the vicinity of the main sewer and of a smaller sewer draining 10 houses.

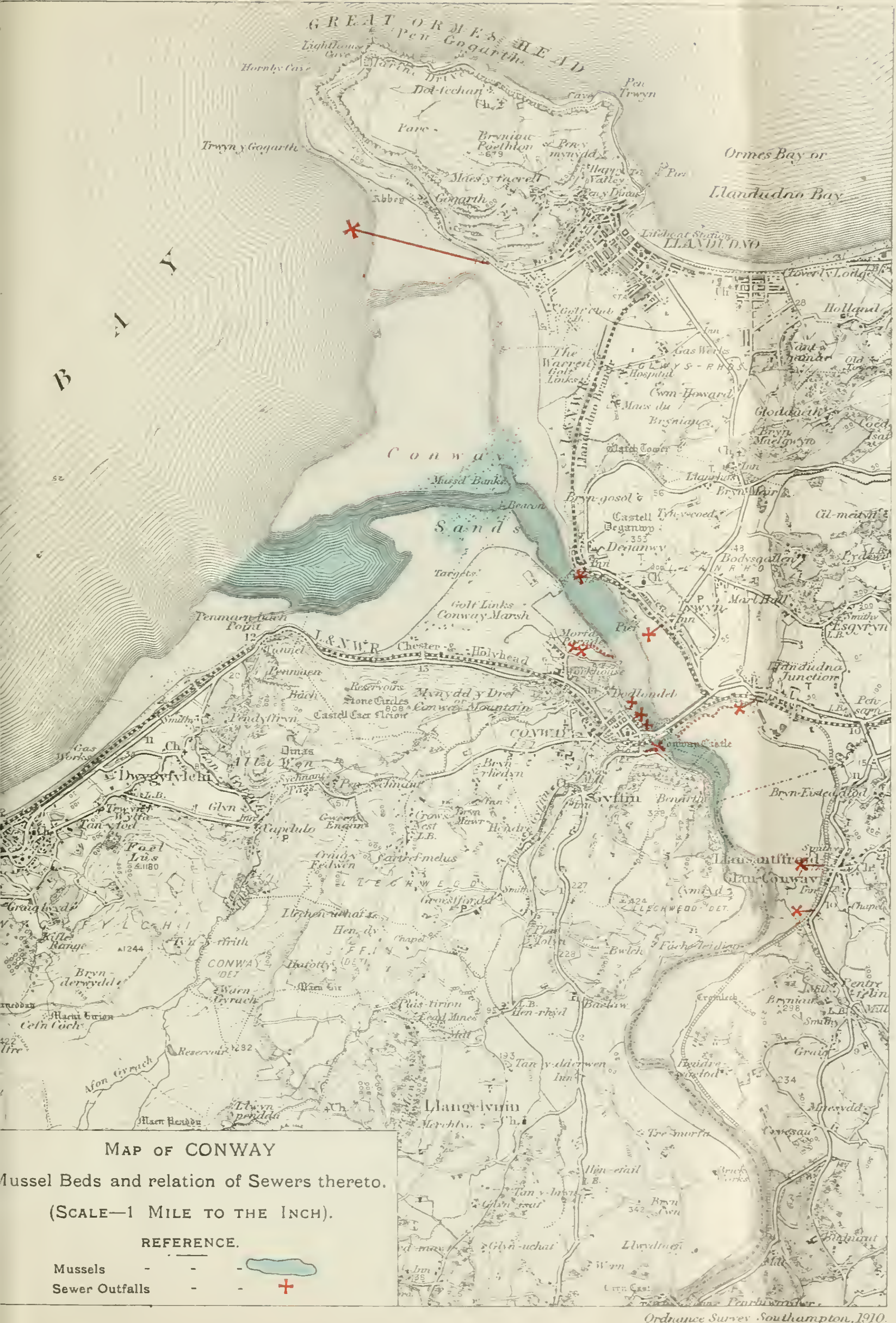
I see no alternative, if the mussel industry at Conway is to continue, but to prohibit entirely the collection of mussels for immediate marketable purposes from the upper portion of the river, *i.e.*, from Glan Conway down to below Deganwy, and I am afraid that there are many arguments which could be adduced in support of the total closure of the estuary as regards mussels for immediate human consumption. But having regard to the dilution which the sewage undergoes, it might be possible, as a provisional arrangement, to allow mussels to be taken from the seaward portions of the estuary, provided that all the washing and separation of such mussels was also carried out there. The present practice of collecting mussels from relatively pure localities and of giving them their final wash or "drink" quite near to sewer outfalls is clearly one not unlikely to bring discredit upon any mussels, however pure the locality from which they were originally procured.

Steps taken since the date of my last visit.

At the time of my last visit to Conway I was informed that Mr. Roberts, a representative of the Fishmongers' Company, was at Conway endeavouring to persuade the mussel sellers to relay their mussels near the mouth of the estuary, and, with the object of encouraging this practice, the Fishmongers' Company had, I understood, drawn up a certificate to be signed by the mussel gatherers or sellers, which certified that the mussels contained in the bag accompanying the form had been laid for at least four days on Moffra Bank, a spot near the mouth of the estuary.

I did not see Mr. Roberts, but as I felt that whatever might be subsequently determined upon this proposal was in the right direction, I informally urged upon the officers of the Fishery District and upon those of the Conway Town Council the importance of taking action at once, and I expressed my opinion to the Mayor in a similar sense, urging, in addition, the very great importance of discontinuing the practice of washing the mussels near the sewer outfalls, a point to which attention had not, it seems, been formerly called.

MAP No 25.



Map of CONWAY

Mussel Beds and relation of Sewers thereto.

(Scale—1 Mile to the Inch).

REFERENCE.

Mussels - - - ▬

Sewer Outfalls - - - +

Ordnance Survey Southampton, 1910.

I have since (October 29th, 1908) been informed by Dr. Travis, the medical officer of health, and Mr. Delamotte, the borough engineer of Conway, that at a meeting between the Town Council of Conway and the mussel merchants of the locality, the fishermen agreed to take the mussels to a place above the Conway outfalls for the purpose of picking them over and washing them.

Mr. Johnstone has carried out some experimental works in connection with the transplantation of mussels to the mouth of the river, and such experiments show that the mussels deposited there rapidly undergo a very material degree of purification.

Later evidence, which has reached me, goes to show that very little, if anything, has been done to alter the conditions which obtained at my inspection.*

The Epidemiological Evidence relative to the Conway Mussels.

Dr. Lewis Travis, medical officer of health of the Carnarvonshire Combined Sanitary District, who, at my request, has gone into the history of enteric fever in this district within recent years, has been unable to produce any evidence which could reasonably be held to incriminate the Conway mussels.

My colleague, Dr. R. W. Johnstone, as the result of an inquiry into outbreaks of enteric fever in the Conway Urban and Rural Districts and in Llandudno Urban District during 1908 and 1909, was unable to associate any of the cases of enteric fever with the consumption of shellfish.†

I have, however, been able to obtain from Mr. William Little, sanitary inspector of Llandudno Urban District, an account of five persons who, with one exception, on October 17th, 1905, consumed at Llandudno mussels purchased at Conway by one of their number.

Two of those who partook of the mussels died of enteric fever, another suffered from a non-fatal attack, while the fourth suffered from gastro-enteritis. The person who abstained from eating shellfish remained well.

Dr. J. M. Johnson, medical officer of health of the Leek Urban District, states in his annual report for 1908, that during December of that year three cases of enteric fever were notified, all of which were, apparently, due to infected mussels, which were traced through a dealer in the Potteries to Deganwy, in North Wales. The authorities there, the report adds, were unable to throw any light on the matter, but expressed the opinion that contamination of the mussels was improbable.

Dr. J. Niven, medical officer of health of Manchester, has in his annual reports for recent years drawn attention to the frequency with which mussels from Conway have been found to be associated with cases of enteric fever in Manchester. Samples of mussels which had presumably caused enteric fever were on numerous occasions submitted for identification to the dealers, and over and over again the verdict of the dealers has been that the mussels in question were Conway mussels.

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* Since the above comments were made a draft Order for the regulation of this shellfish industry has been drawn up which purports to confer powers upon the Town Council for preventing, so far as practicable, the pollution of the Conway mussels.

† Reports to the Local Government Board on Public Health and Medical Subjects (New Series, No. 28).

Suspicion as regards the enteric fever carrying capacity of the Conway mussels has also arisen in certain other towns, and it is obvious from the account of the industry furnished above that the mussels in course of their preparation for market have abundant opportunities of becoming sewage infected.

THE SHELLFISH INDUSTRY IN THE ESTUARY OF THE DEE. (Map No. 29.)

The estuary of the Dee, which extends from Connah's Quay to a line joining Point of Air, on the Welsh Coast, to Hilbre Island, on the Cheshire Coast, attains at its broadest part a width of from 5 to 6 miles, the average width being about 4 miles.

At high tide the whole of this area is covered with water, but at low tide the water is confined to the channels, which leave between them expanses of sand, the configuration of which is apt to undergo material modification from time to time, and as a result the maps of the estuary are not altogether to be relied upon some years after the survey to which they relate has been made. The chief channels of the estuary, which are not marked on the map, are known as Montague Deep, Salisbury Gut, Dawpool Deep, and Flint Deep.

The mussel industry hereabouts is one of considerable magnitude, and the mussels are despatched by train to Manchester, Liverpool, Chester, Blackburn, Bolton, Burnley, Leeds, Wigan, Warrington, St. Helens, Oldham, Leicester, Birmingham, and Northwich. They are also hawked in carts at Birkenhead, Chester, Connah's Quay, Flint, Bagillt, Wrexham, St. Asaph, and other places. This list, which was furnished to me on the occasion of one of my visits by Mr. Simpson, the late Superintendent of Fisheries, will afford some indication of the damage which specifically polluted shellfish from this locality might conceivably occasion.

The mussels are found in Dawpool Deep, on Hoyle Bank, over Seldom Seen Rock on Salisbury Middle, and at intervals on the foreshore from Caldy Islands to landward of Gayton Cottage, as shown on the map by blue colouration.

In Dawpool Deep and over Seldom Seen the mussels are obtained almost entirely by rakes, but on the sandbanks and on the foreshore they are, very largely, handpicked. The mussels when collected are taken for the most part to Parkgate.

In Dawpool Deep the area covered by the mussels extends from Caldy Blacks, on the west, to Farnhall, near Heswall, on the east, a distance of about 2½ miles.

The mussel beds are very extensive, and at low tide there are large areas over which the shellfish may be hand-gathered. In the channel, however, iron rakes with handles, up to 35 feet in length, are used.

Each boat is able to collect about 1 cwt. of mussels between the tides, and the mussels are then despatched in bags to the large towns already mentioned. Each bag fetches from 3*s*. to

6*s*., according to the state of the market. In very stormy weather no mussel operations can be conducted, and hence the price of the shellfish is enhanced.

Practically, all the mussels in the Dee are, I am informed, used for human consumption, none being utilised as bait.

The number of persons employed in the industry or dependent thereon.

There are, I am told, about 30 boats engaged in the mussel fishery; sometimes more, and sometimes less, and some of the fishermen state that when the mussels are very plentiful as many as 100 boats may be seen raking. But this is very rare. In addition to the boats, there are between 30 and 40 handpickers, many of whom are brought down by boats from villages on the Dee and put ashore on their arrival at Dawpool. When the tide covers the mussels the handpickers are taken with their mussels into the boats.

In order to protect their fingers from damage in collecting the shellfish, use is made of a small two-pronged fork, by means of which the mussels are lifted from their bed. The mussels, which are ebb-dry, are much smaller than those which are covered with water at all states of the tide, since these latter are always being supplied with food, while the former are deprived of their nutriment for more than six hours out of every 12.

The boats and the handpickers come from very long distances; some from as far as Chester, about 16 miles away.

The custom is to "follow the tides round," as it is termed, *i.e.*, the boats start from home at such an hour, whether at day or night, as will enable them to reach the mussel beds when the tide has sufficiently ebbed to allow either of raking or handpicking. In this way, some of the mussel gatherers are away from home from 12 to 14 hours at a stretch.

Some idea of the quantity of mussels despatched by rail (*i.e.*, exclusive of mussels which are hawked in carts) from the stations on the English and Welsh coasts of the Dee, may be gathered from the fact that during recent years the average is estimated at some 1,300 tons per season. A marked increase took place after 1893, a fact which is attributed to the regulations imposed upon the industry by the Dee Fisheries Committee. It is difficult to estimate the number of persons dependent upon the mussel industry in the estuary of the Dee, but, taking the average number actually employed as 60, and regarding half of them as having families dependent upon them, there may be between 150 to 200 persons dependent upon this industry, a number which, of course, does not take into account the persons engaged in distributing and selling the mussels.

The Liability of the Dee Mussel Beds to be Contaminated.

Upon the accompanying map (No. 29) are marked by red crosses the positions of such of the sewer outfalls entering the Dee as are likely to influence the mussel beds in that estuary, and it will be apparent that certain beds are much more liable to pollution than others.

Those which would appear to be most liable are those which are situated on the foreshore opposite Heswall and Gayton, since these are in close proximity to the sewers draining these villages.

It will be seen that landward of Gayton there are two outfalls —one from Parkgate, the other from Neston—the former discharging untreated sewage on to the foreshore well above the creek; the other discharges a relatively clear effluent from bacterial beds. The risks to be apprehended from these two outfalls are small as compared with those from the two Heswall outfalls, both of which discharge quite crude sewage, practically, into the channel and on to the foreshore, where mussels are at times collected in considerable quantities, and although the amount of sewage from each outfall is small, the risk is so obvious that it is not necessary to emphasise it.

The mussels in the main channel westward of Heswall are materially less liable to pollution, since they are covered at all stages of the tide by several feet of water. But it will be noted that the distance from the nearest Heswall sewer is not more than a mile from the nearest mussel beds in the main channel, although the more important beds are situated off Thurstaston, some three miles from this outfall.

Apart from these outfalls landward of the mussel beds there are two 12-inch sewers discharging off West Kirby, each of which discharges the crude sewage of, approximately, 4,000 people. The sewers discharge at all states of the tide, except at and near high water, when they are tide-locked. Both these outfalls discharge into rivulets or gutters, which run westward across the sands and empty into the deep main channel—hence, the risks from this source are not, perhaps, great.

The main West Kirby and Hoylake outfall discharges on the north of the Wirral peninsula, near Dove Point, the sewage being held up in a tank during quite the height of the tide. The risks to the mussels on Salisbury Middle and Hoyle Bank are probably very small.

The most urgent reforms needed in the case of the Dee mussels are the absolute prohibition of the collection of mussels for human food in any part of the narrow channel opposite Heswall and Gayton, as well as from the main channel near the entrance of the Heswall Creek.

In order, however, to still further reduce the risks of specific contamination, it would be well to transplant all the mussels on to the Salisbury Middle and Hoyle Bank sands, and to there subject them to a process of cleansing and quarantine.

The Cockle Industry in the Dee.

Over many of the sandbanks, which dry at about half-ebb in the Dee estuary, large quantities of cockles are collected by men coming from Parkgate and other places. Parkgate is the chief centre for the prosecution of this industry, and it is from Parkgate Station that the cockles are despatched by train to numerous large towns. But the cockles also come from other places in the estuary, and a certain number of cockles collected on the Mostyn Bank Sand are sent away by rail from Mostyn Station. In addition to the cockles sent by rail, many are hawked about the districts bordering on the Dee.

The cockles, I am informed by Fishery Officer Richard Wright, are sent, like the mussels, to some of the following towns:—Manchester, Chester, Liverpool, Warrington, Burnley, Shrewsbury, Oldham, Wigan, Bradford, Nottingham, Wrexham, Huddersfield, Crewe, and Wolverhampton.

Risks of Contamination to Cockles.

It will be seen by a reference to Map No. 29, where the cockle areas are coloured green, that the greater number of these shellfish are collected from sandbanks which only dry at or near low tide, and which are, for the most part, cut off from the foreshore by permanent channels of water. Under these circumstances, the sewage in the water of the estuary could only reach the cockle beds when in a state of very great dilution. But there are certain exceptions to this rule in the Caldy Sands cockle beds near West Kirby, and of the Mostyn beds near Mostyn Quay. In these cases it would be unsafe to collect cockles near the West Kirby outfall or near Mostyn Quay, and regulations to this effect should be made and duly enforced.

MUSSEL " SCALPS " IN THE ESTUARY OF THE MERSEY. (Map No. 29.)

The only mussel beds in this estuary are, fishery officer Eccles tells me, situated on the southern or Wirral Bank. One of these is at Wallasey, near New Brighton, another near Egremont Pier, and the third—a small one—at Rock Ferry.

The Wallasey Mussel Bed.

This bed extends for nearly two miles along the northern shore of the Wirral peninsula, commencing at the Rock Lighthouse and extending as far westward as opposite Wallasey Station.

The bed only ebbs dry at low water of spring tides, and at the present time (1909) there are not many marketable mussels therein, but at some seasons when the mussels are well " fished," a large number of persons may be seen collecting.

The nearest sewer to this mussel bed is one of the Wallasey sewers, a 36-inch pipe, which discharges the crude sewage of some 8,000 persons, practically, alongside the Rock Lighthouse at the mouth of the Mersey (see map).

On April 7th, 1909, I visited this bed in company with Fishery Officer Eccles, and near low water we were able to trace the sewage, by signs which were unmistakable, for fully half-a-mile westward of the Rock Lighthouse, a fact which is in keeping with the trend of the ebb tide from the Mersey.

The main waters of the Mersey pass out to sea through the Queen's Channel, but, in the first part of the ebb, the waters along the western bank are carried down the Rock Gut westward through the Rock Channel, which runs between Mockbeggar Wharf Sand, upon which the mussel bed is situated, and North Bank Sand opposite. Under the above circumstances, it is clear that no mussels should be taken from this bed for human consumption.

At the date of the above visit, I saw a man and woman—evidently holiday makers—collecting mussels from within a few yards of this sewer outfall, and under conditions which were absolutely repulsive. When remonstrated with, they replied, that the sewage would fatten the mussels and render them better eating. It is to be feared that this indifference to fæcal contamination is by no means rare, and the shellfish-eating public would do well to take it into account.

The Egremont Bed.

This extends over a considerable area seawards of Egremont Pier, at a level slightly above low-water mark. At the date of my first visit, which was during spring tides, the whole of the scalps were exposed. There were, however, but very few mussels on the beds at that time, and only a small proportion of these were of legal size. Indeed, Mr. Eccles informed me, that there had been practically no mussels on these beds for several years. He had, however, seen the whole area, a mile or more in length, thickly covered with the molluscs, and a large number of persons in the act of collecting them.

There are eight separate outfalls discharging crude sewage directly into the Mersey hereabouts. The largest, which takes the sewage of about 50,000 people, discharges south of Seacombe Ferry, some 2 miles from the mussel bed. But as will be seen there are other and smaller sewers discharging quite near to the mussels.

On the occasion of one of my visits, I saw two women collecting mussels from this bed, the mussels being then taken direct to Liverpool.

Mr. Eccles has seen several persons collecting mussels near the former outfall, and has done his best to dissuade them from so doing, and the Wallasey Urban District Council, acting on the advice of Dr. Craigmile, the late medical officer of health, posted notices warning persons from indulging in this practice.

There can be no question whatever that no mussels for human consumption should be collected from this bed.

The Rock Ferry Mussel Bed.

This, a small and relatively unimportant bed, is situated on the western side of the Mersey, near the Rock Ferry and New Ferry Piers. Mr. Eccles informed me, at the date of my first visit, that there was no great sale for these mussels, inasmuch, as owing to some local industry thereabouts, the mussels tasted of paraffin.

Immediately to the south of the bed is one sewer, and further to the south, on either side of the New Ferry Pier, are two other outfalls. It is unnecessary to insist upon the risks of specific pollution to which the mussel bed is liable on the ebbing tide.

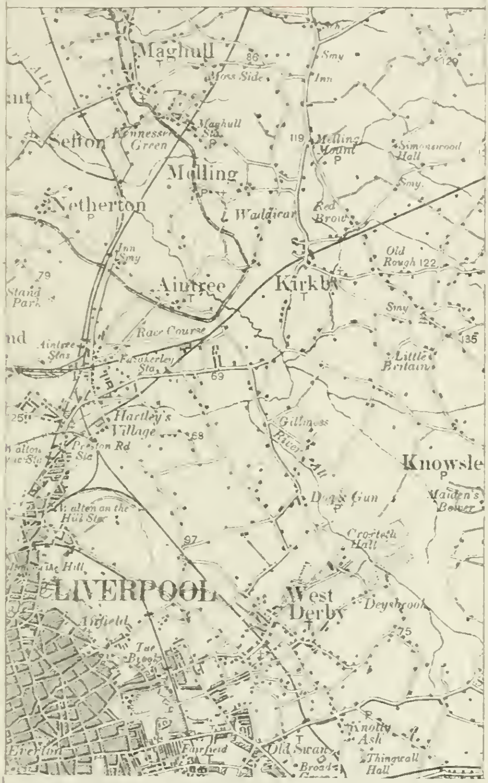
MAP No. 29.

ls and Cockle Beds in and around the
f the DEE and the MERSEY, and the
ion of the Sewers to such beds.

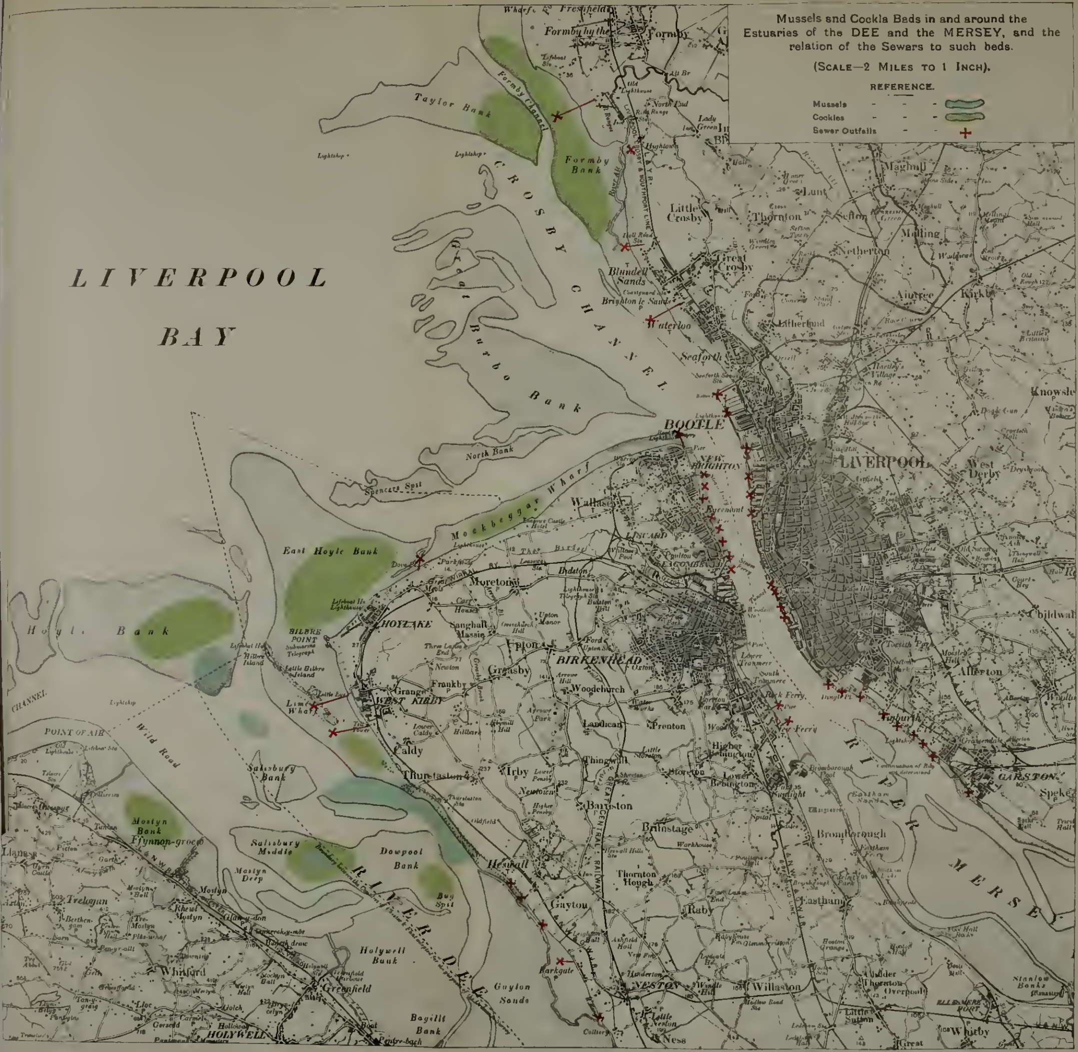
(SCALE—2 MILES TO 1 INCH).

REFERENCE.

Mussels - - - 🟦
Cockles - - - 🟩
Sewer Outfalls - - ✚



MAP No. 29



Mussels and Cockle Beds in and around the Estuaries of the DEE and the MERSEY, and the relation of the Sewers to such beds.

(Scale—2 Miles to 1 Inch).

Epidemiological Evidence.

As will be seen on page 71, chapter VIII., Dr. Hope, the medical officer of health of Liverpool, has seen no reason to ascribe Liverpool enteric fever to the consumption of shellfish; and the experience of Dr. T. W. N. Barlow, medical officer of health of Wallasey, and for many years medical officer of health of Bootle, has been practically the same, as also has that of Dr. Daley, medical officer of health of Bootle.

Dr. Sergeant, county medical officer of Lancashire, in his quarterly report dated August, 1907, refers to an outbreak of enteric fever in which Dr. Jordan, medical officer of health of Heaton Norris, throws suspicion on certain mussels which were obtained by the patients from the Wallasey mussel beds.

THE FORMBY COCKLE BEDS. (Map No. 29.)

These beds cover, as shown on map No. 29, a considerable strip of the foreshore bordering upon Crosby and Formby Channels, and extending southwards as far as the River Alt. Cockles are also to be found in large quantities on the sandbank known as Taylor Bank on the seaward side of Formby Channel.

Risks of Contamination.

Formby Urban District had in 1909 an estimated population of 6,342, and at that time about a third of this population was connected with the sewerage system recently completed. This system takes the sewage alone, the rain water being dealt with separately, and the sewage, after septic-tank treatment, is liberated at the point shown on the map. The outfall, which ends at about 50 yards above low-water mark, discharges for about two hours at the end of the ebb, and for about the same period at the beginning of flood.

It is clear from the topographical conditions which obtain here that, notwithstanding the septic-tank treatment, no cockles should be collected in the vicinity of the Formby sewer outfall.

Another source of possible pollution to the Formby cockles is the River Alt, which discharges into Crosby Channel to the south of the cockle beds, and which is by no means an entirely unpolluted stream, as, in addition to pollution further inland, the crude sewage of Hightown, with a population of some 200, enters it opposite Hightown, and during its passage over the sands it receives the crude sewage of Great Crosby, with a population of over 10,000.

But the pollutions of the Alt are not nearly so dangerous to the Formby cockles as the effluent of Formby sewage itself, since the Alt, running as it does in what is practically a depression in the sands, must be enormously diluted on the rising tide before any of it can reach the cockle beds, which are at a considerably higher level.

Southward of Crosby is a sewer from Waterloo, and further south, at the junction of Seaforth and Bootle, there is a joint sewer taking the crude sewage of a population of some 30,000.

Epidemiological Evidence.

Dr. Francis Carter, medical officer of health of Formby, has had no reason to suspect either cockles or mussels as a source of enteric fever in his district; and Dr Limrick, medical officer of health of Great Crosby and of Waterloo with Seaforth, has had a similar experience as regards Formby cockles. But he tells me that in 1897 he had to attribute five cases of enteric fever to the consumption of cockles gathered near the joint Seaforth and Bootle sewer.

Dr. Sergeant, county medical officer of health of Lancashire, states that in his annual report for the year 1903 the medical officer of health of the West Lancashire rural district furnished the instance of a female, aged 41, who was attacked with enteric fever ofter having eaten freely of cockles about a fortnight previously, the cockles having been gathered from a bank not far from the outlet of the Crosby sewer.

THE COCKLE BEDS IN THE RIBBLE ESTUARY.

(Map No. 30.)

As will be seen by map No. 30, where the cockle beds are coloured green, there are very extensive areas hereabouts, over parts of which cockles are in different years collected.

In former years cockles were collected over the Banks Sands to the east of Crossens Pool, but I am informed that none have been so collected for many years past. It is, however, of course, possible that cockle beds may one day be again found over these sands.

These beds are worked by people from Banks, Preston, Lytham, St. Anne's-on-the-Sea, and elsewhere, the cockles being despatched to Lancashire towns by train, and sold locally in the neighbourhood by hawkers.

Liability to Contamination.

A glance at the map will suffice to show that some of the cockle areas are liable in only small degree to direct sewage contamination, while certain others are so in an imminent degree. For the most part, the cockle areas are cut off by more or less deep channels from direct sources of the pollution, while others, such as some of the Ansdell cockle beds, cannot fail to be polluted, since the Fairhaven outfall discharges just in the middle of a very prolific cockle bed.

On the south side of the estuary the main direct source of pollution is the effluent from the Southport Sewage Works, which enters the entrance to "Crossens Pool" at the point indicated, and passes along the Pool to reach the sea, viâ Packet Heading. The treatment to which the Southport sewage is subjected is by septic tanks and continuous bacterial filters. It has to be mentioned, too, that this Crossens Pool is, practically, a continuation of "Fine Jane's Brook," which receives the effluent from the sewage of Birkdale, an urban district immediately to the south of Southport, after treatment by sedimentation, filtration, and irrigation.

There is also the question of the effluent from the Preston Sewage Farm to be considered. This effluent enters the channel of the river by three separate outfalls. One—the main outfall—enters at a point distant about five miles from the nearest cockle area, while the other two enter what is known as the "Naze Brook," which discharges into the channel of the Ribble about four miles from the nearest cockle area.

The river channel, into which the effluent discharges, is at low tide 100 yards wide and some 2 feet 6 inches deep, according to a recent chart of the Ribble estuary, with which Mr. A. Howarth, the Town Clerk of Preston, was good enough to furnish me. It is important to notice that, as regards the cockle beds, none of the sewage farm effluent can reach them on the ebb, since the tidal flaps covering the outfalls cannot open owing to the head of water in the estuary, until the level of the river water has sunk below the training walls, and the water is emptied to the channel proper, already referred to. Similarly, on the flowing tide, the sewage effluent in this channel on the early flood will be forced up beyond the outfalls before any of it can rise above the level of the training walls. But it has, nevertheless, to be borne in mind that the effluent which is forced up on the flood, must return on the ebb, and that some of this on the early ebb—before the water sinks below the level of the training walls—may not improbably pass in an enormously diluted condition over the sand upon which the cockles grow. But, at the same time, having regard to the pollutions which are brought down by the Ribble and its tributaries, and by the River Douglas as well as by the Southport effluent, which passes near to the cockle area, the Ribble cockles cannot be regarded as other than in some degree liable to pollution, although such liability, in view of the fact that the estuary hereabouts is some 6 miles broad, must be remote, except in regard to cockles collected near to or washed in Crossens Channel.

In Appendix VI. of the Fifth Report of the Royal Commission on Sewage Disposal, the Commissioners who visited the Ribble estuary for the Commission say:—

"Our general impression of the whole Ribble estuary was "very favourable. In spite of the extensive and populous dis-"trict draining into it, and the varied industries contributing "their trade effluents, no marked indications of pollution are "to be found even a few miles below Preston, while at Lytham "all signs have disappeared."

Preston has an estimated population of about 120,000, and its sewage is treated by coarse screening, sedimentation in tanks, and irrigation over about 500 acres of land. The effluents at the date of my visit (April, 1909), when I saw them shortly after the tidal flaps had been liberated, were not first-class effluents. There was too much black suspended matter in them, and the opinion I formed was that irrigation was not carried out in a fashion to yield the best results. During high tide, the effluent accumulates as a large pool behind each outfall, where it appears to deposit the suspended matter which it contains. When the filtration is carried out in a better fashion, the effluent should not contain so much matter in suspension.

Fifth Report of Royal Commission on Sewage Disposal. Appendix VI. [Cd. 4284] 1908. Price 9*s.* 7*d.* Wyman & Sons.

Epidemiological Evidence.

No evidence has been brought to my notice as to causation of enteric fever by consumption of Ribble cockles, but these cockles have evidently, through hawkers, a wide range of distribution in rural districts, where their influence for harm, if any, might be difficult to detect.

Dr. Weaver, medical officer of health of Southport, tells me that although he has made investigations into the subject he has never found shellfish responsible for any case of enteric fever in Southport; and Dr. A. V. Wheeler has had a similar experience with regard to the urban district of Birkdale, which is situated immediately to the south of Southport, and for which he is medical officer of health. It appears that the cockles supplied to Southport are gathered from the sands to the north of the pier, where there can be but little risk of contamination except, perhaps, from one of the Southport storm overflows, which discharges hereabouts.

THE LYTHAM MUSSEL BEDS. (Map No. 30.)

The mussel beds in the vicinity of Lytham are three in number, and they occupy the position shown on map No. 30. None of these beds are at present (1909) of first-class importance, but, at times, when a plentiful fall of spate has had opportunities for development, large quantities of mussels are collected from them. At such times, especially on Sundays, a large number of men with carts from surrounding districts are to be seen collecting mussels from these "scars."

The mussels, which are despatched from Lytham by train, go, for the most part, to Bolton, Preston, Blackburn, and Bradford.

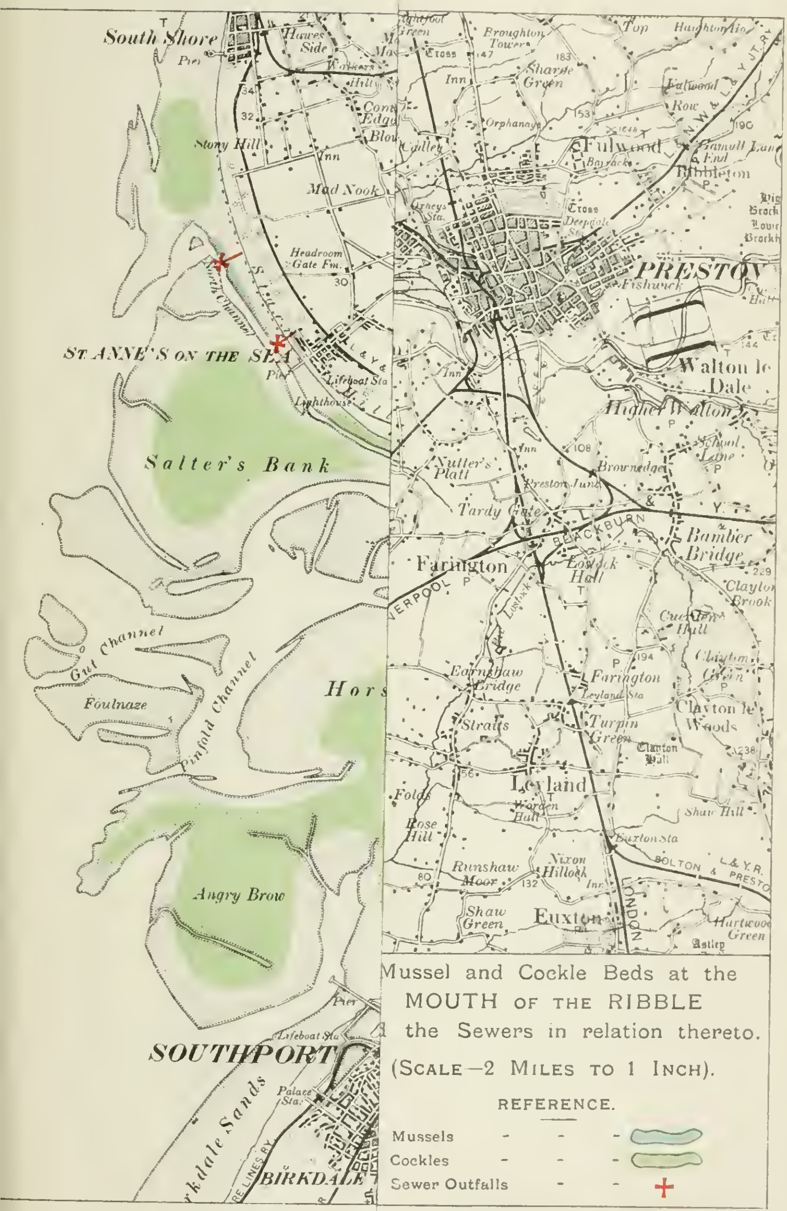
Risks of Contamination.

The sewage of Lytham, with an estimated population of 10,092, is discharged crude by two different outfalls.

The east end outfall, which drains a population of about 6,000, is coarsely screened and held up in tanks. It is liberated about one hour after the commencement of ebb, the penstock being closed at about half-ebb. This east end outfall discharges at present (April, 1909) into the Lizzard Brook, but arrangements have been made for carrying the outfall down to the channel as shown on the map, and in a position about three-quarters of a mile from the nearest mussel bed.

The other—the Fairhaven outfall—is a 15-inch pipe which carries the crude sewage of about 4,000 people, and which discharges into a small pool in the sand at a considerable distance from the channel. It is not improbable that some of the sewage from this outfall may, under certain circumstances, reach the mussels on Church Scar, but it is doubtful whether any of it can reach the mussels on the south side of the North Channel. Deposits of paper may be detected at considerable distances to the east of this outfall.

Both these Lytham beds are not, therefore, free from risks of pollution by sewage.



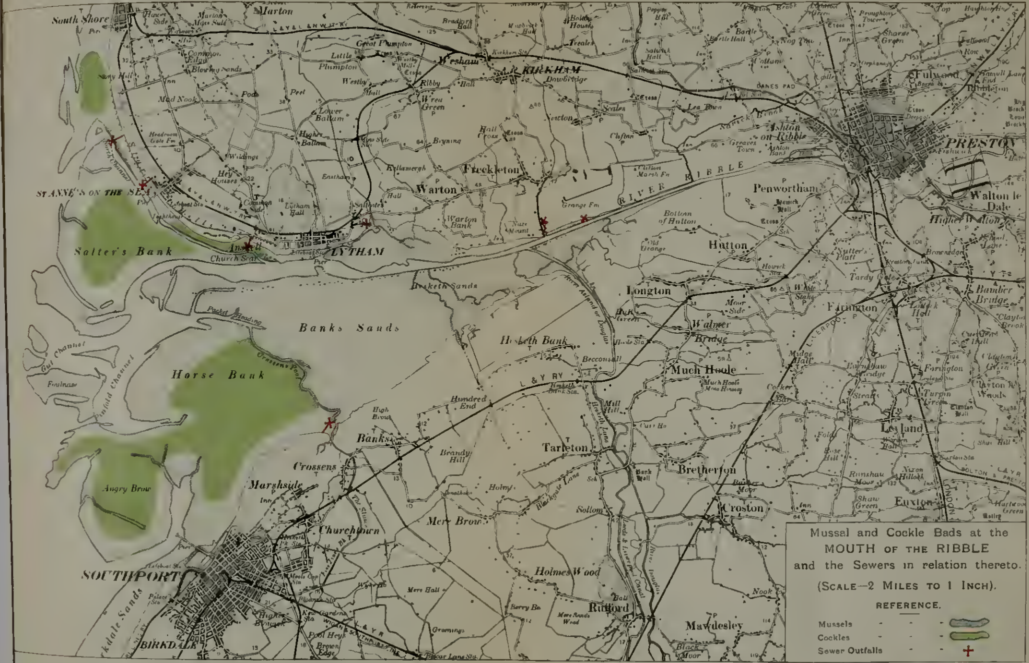
Mussel and Cockle Beds at the
MOUTH OF THE RIBBLE
the Sewers in relation thereto.
(SCALE—2 MILES TO 1 INCH).

REFERENCE.

Mussels - - -	▭
Cockles - - -	🟩
Sewer Outfalls - -	+

Ordnance Survey, Southampton, 1910

MAP No. 30.



Mussel and Cockle Beds at the MOUTH OF THE RIBBLE and the Sewers in relation thereto.

(SCALE—2 MILES TO 1 INCH).

REFERENCE.

Mussels - - - 🟦
Cockles - - - 🟩
Sewer Outfalls - - +

Ordnance Survey, Southampton, 1910

MAP NO. 30.

THE ST. ANNE'S MUSSEL BED. (Map No. 30.)

At the date of a former visit this bed was much more extensive than it is at the present time (April, 1909), the diminution in the area of the bed having been largely brought about by the choking up of the former channel with sand.

Formerly, the mussels extended along the foreshore from a short distance northwards of St. Anne's Pier to the northern end of the north channel, but at present they occupy only the northern portion of that channel, as shown on the map.

Liability of the St. Anne's Mussels to Contamination.

The sewage of St. Anne's, which has a population of about 7,000, is discharged untreated into the North Channel by means of two 24-inch outfalls, which are situated in the positions indicated on map No. 30.

At the present time the end of the southern outfall, which takes the greater part of the sewage, is cut off by sandbanks from the main channel, but the north-western outfall, which now takes little sewage but which may eventually drain a large number of houses, discharges well into the channel near its northern end, and, practically, in the midst of the mussel bed, and there can be no question but that the mussels hereabouts are seriously liable to sewage pollution; in fact, some of them are literally bathed in sewage. It may be noted, too, that at the date of my last visit with Mr. Wright, the Fishery Officer, I saw three men waiting near the sewer outfall until the tide had sufficiently ebbed to allow them to collect mussels in the vicinity.

Attempts have been made both by the Lancashire and Western Sea Fisheries Committee and by the St. Anne's District Council to prevent the collection of mussels from the locality, but little success has apparently attended their efforts. I gather from Mr. Wright that the Sea Fisheries Committee on one occasion reported a batch of mussel gatherers to the district council, and proceedings were taken in one case. The district council have also endeavoured to plough up the mussels, have employed watchers, and have issued notices, but all these things have availed, it appears, but little.

A notice was issued by the district council in July, 1908, which cautioned the public against collecting the mussels, "as "during the months of May, June, July, and August the mussels "are out of season, and are, therefore, exceedingly dangerous "as an article of food."

Needless to say, the St. Anne's mussels should not be eaten at any period of the year, and numerous cases of enteric fever have been ascribed to these molluscs at Blackpool and elsewhere.

THE MUSSEL BEDS IN THE WYRE AT FLEETWOOD.
(Map No. 31.)

The mussel beds in the estuary of the Wyre are extensive, and Captain Wright, the Fishery Officer of this part of the Lancashire and Western Sea Fisheries District, tells me that there are, more or less constantly, some 30 persons—mostly males—engaged in mussel collection hereabouts, while, occasionally, as many as 60 persons may be seen thus engaged. The mussel gatherers come from Knott End, Fleetwood, Hambleton, Staynall, and Preston; and the mussels when collected are despatched to Blackburn, Bolton, Bradford, and Preston.

The mussels are situated partly on the banks, between tidal limits, partly in the channel itself, and, as a consequence, both hand-picking and raking are resorted to in their collection.

The mussels are found in places from the Inn at Hambleton to the commencement of the Wyre Docks, the best mussels being found in the upper portions, where they are known as "Hambleton Hookers," and have, I understand, a great reputation. Hereabouts, the mussels are for the most part in the channel. From the Chemical Works downwards the mussels are found both in the channel and on the foreshore, but the foreshore mussels, owing partly to their being too long out of water and partly to the occasional presence of an offensive liquor from the Fish Curing Factory near, are not of good quality. Such as are gathered are used either for bait or for relaying in the bed of the channel itself.

Immediately opposite the Fleetwood Docks there are few if any mussels, but seaward of Fleetwood Ferry they are to be found in considerable abundance both on the foreshore on either side and in the channel itself nearly as far out as the lighthouse. Here, again, the foreshore mussels are used for bait and relaying in the channel, the channel mussels being utilised almost exclusively for human food.

Sources of Contamination.

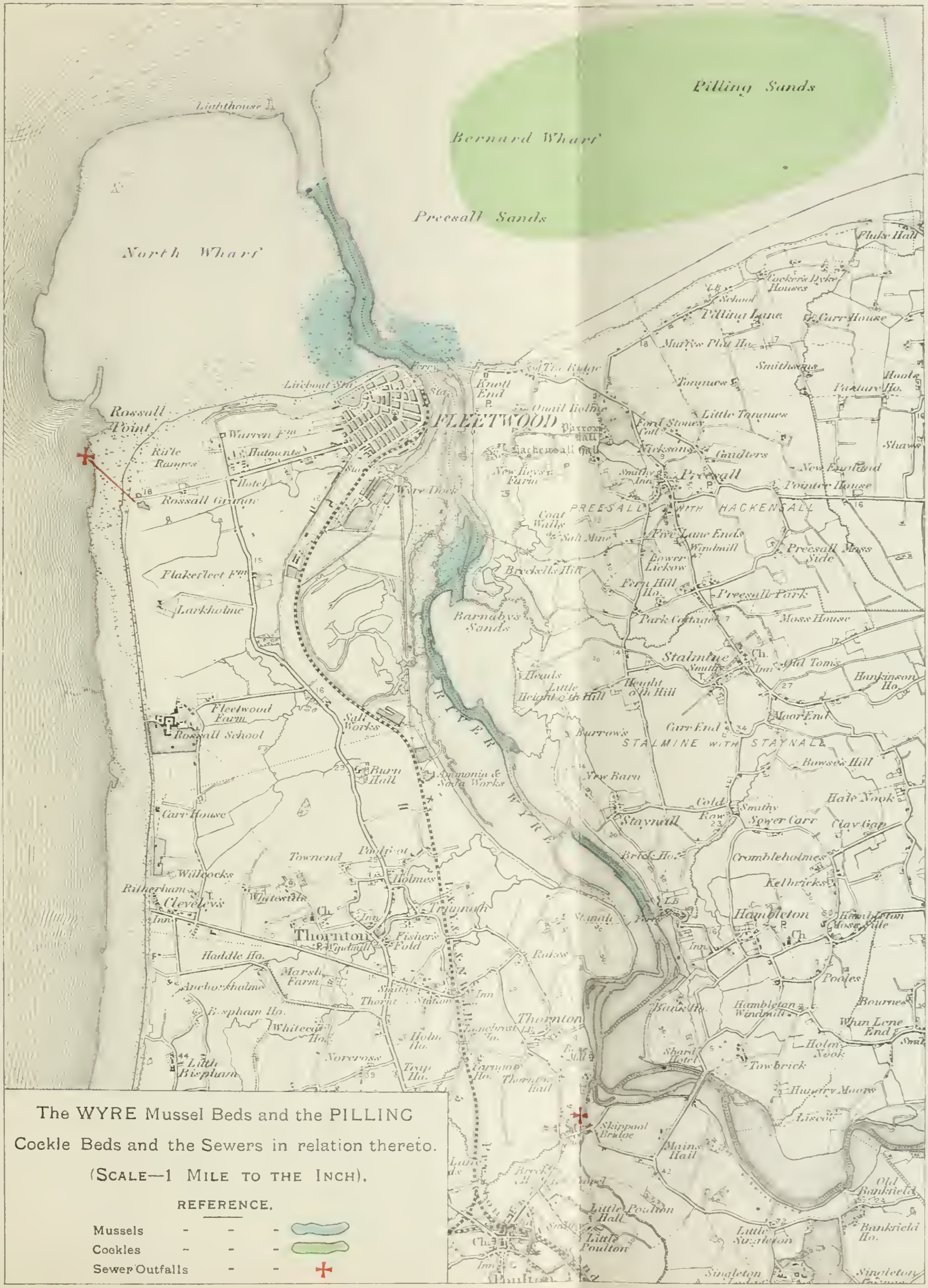
Until recent years, the whole of the sewage of Fleetwood, with a population estimated at the present time (1909) at 15,000, discharged untreated into the estuary of the Wyre, between the Ferry and the Docks, by means of five separate outfalls. But the sewage has now been diverted from these outfalls and taken to a new outfall at Rossal Point, where it is liberated on the last hour of the flood tide and the first few hours of the ebb. It was found, by means of a series of float experiments, that when the sewage is thus liberated it is carried directly out to sea.

At the present time the sewer outfall nearest to the mussel beds is that from Poulton-le-Fylde, which discharges untreated into the Wyre near the red cross on map No. 31.

Of the old Fleetwood outfalls, the largest is quite cut off, but the remaining three are used as storm overflows.

The Pilling and Cockerham Sands Cockle Beds.
(Maps No. 31 and 32.)

These beds extend over the sands between the mainland and the estuary of the Lune, and some 20 persons are regularly at work collecting the molluscs. The cockle gatherers come mainly from Fleetwood, and the shellfish collected are hawked in Fleetwood and the surrounding villages.



The WYRE Mussel Beds and the PILLING Cockle Beds and the Sewers in relation thereto.

(SCALE—1 MILE TO THE INCH).

REFERENCE.

Mussels - - - 🟦
Cockles - - - 🟩
Sewer Outfalls - - ✚

Ordnance Survey, Southampton. 1910.

THE MUSSEL BEDS IN THE LUNE. (Map No. 32.)

Although the estuary of the Lune, especially near its mouth, contains a large body of water at and near high tide, its dimensions at low water are small and the channel shallow. There are near the mouth, as shown on map No. 32, two mussel beds, one on either side.

The more important bed of the two is that known as "Crook Skear," which extends for about a mile beyond Glasson Dock to the outer lighthouse. The other bed, which is situated off what is known as Sunderland, is of smaller dimensions, and contained, at the date of my visit in April, 1909, few mussels.

But over the whole of the training walls, which extend, as shown on the map, from Sunderland to Bazil Point, there are innumerable mussels which, from overcrowding, are becoming grown over and stunted. Not only are mussels to be seen on either side of this training wall, but also on the top, where they occupy the interstices between the stones. I am informed that the fishermen are not allowed by the Lancaster Corporation to collect these mussels owing to the fact that such collection might weaken the training wall. A considerable amount of transplanting of mussels from the Lune foreshore beds down into the channel has taken place under the auspices of the Lancashire and Western Sea Fisheries Committee, and the result in so far as the mussels are concerned is considered satisfactory, the growth of those laid down near the mouth of the estuary having been very rapid. At the present time, mussels may be raked for over parts of the channel, coloured blue on the map.

At the date of my visit there were at least 13 boats engaged in the collection of mussels, there being, in addition, some handpickers. But I am told by Mr. Wright, the Fishery Officer, that at times the number of boats is much greater, fishermen coming from many places to collect the Lune mussels.

The mussels are for the most part despatched from Glasson Dock Station, and they are sent to amongst other towns, Manchester, Burnley, Preston, and Todmorden.

Liability of the Lune Mussels to Contamination.

The chief source of pollution in the Lune estuary is the sewage which is contributed from the several sewers of the borough of Lancaster, which comprises a population of about 43,329, and which discharges all its sewage untreated into the Lune.

The bulk of the sewage, that from a population of about 34,000, discharges into the estuary as it passes through the town, but rather under 2 miles from the town there discharges the drainage from the Isolation Hospital, and at Stodday, which is about 3½ miles from the nearest mussel bed, there discharges the sewage of a population of 9,000, while at Glasson itself there enters the drainage from that aggregation of houses.

At the date of my visit to the mussel beds, when I was accompanied by the Fishery Officer, I was unable to discern any naked-eye appearance of sewage pollution, but the Fishery Officer informed me that he had on other occasions seen much fæcal matter on the west side of the river. Mr. James Johnson, in 1904, also examined shellfish taken from the Skears in the Lune, and he found a large number of colon organisms in each group. From this and other examinations, it was concluded that "the "mussels both from Crook Skear and Bazil Point were infected "with sewage matter, but that the degree of such pollution was "not excessive."

In 1902 a petition was presented to the Lancashire County Council by the Conservators of the Lune, Wyre, Keer, and Cocker Fishery Board, and by persons engaged in the fishing industry, who were living at Bazil Point, Sunderland Dock, and Glasson, complaining of the polluted state of the River Lune below Skerton Weir.

It was alleged that deterioration of the salmon fishing in the Lune has been largely brought about by the Lancaster sewage, and that the health of fishermen and the public was jeopardised by such pollution.

It was also suggested that in course of time the mussel beds themselves might become seriously contaminated.

Dr. Sergeant, the county medical officer of health, stated that he inspected the river in October, 1902, and in June and August, 1903, when he found "the river banks extensively "covered with slimy estuarial deposit, impregnated with sewage matter"; but, at the date of the report in April, 1904, before which there had been extensive floods, the sludge had been washed away and the banks left comparatively clear. This was the condition at the date of my own visit, although it was quite clear that in the neighbourhood of Crook Skear the formation of eddies takes place, which has the effect of depositing seaweed and other refuse, much macerated; nevertheless, Mr. Halliwell, of the Ribble Watershed Department, who, in August, 1903, and February, 1904, obtained several samples of water from Sunderland Point during various states of the tide, obtained favourable results, and did not discover the presence of appreciable sewage pollution.

But Professor Delépine, who investigated the matter for the Lancashire County Council, states, that at the date of his visit there was clear evidence of pollution at the level of Crook Skear, and still more along the Bazil Point Weir, and he expressed the view that mussels grown on the beds situated at these places, are certainly exposed to fæcal pollution, which may at times become dangerous.

The most unsatisfactory feature in this estuary is, in my view, the large quantity of sewage which is liberated at the Stodday outfall, which is little over 2 miles from the nearest shellfish beds, and, under all the circumstances, it has to be concluded that the Lune mussels are subject to risks of specific pollution, which render them unsuitable for human consumption without relaying in purer water. I do not, however, regard the Lune as so highly polluted as the petitioners of 1902 appear to have believed.

Epidemiological Evidence.

Dr. Parker, the medical officer of health of Lancaster, tells me that he has had no reason to suspect the Lune mussels as a source of enteric fever in Lancaster during the period for which he has held the post of medical officer of health.

Dr. Haworth, medical officer of health of Darwen, has furnished me with a list of the cases of enteric fever which occurred in that town during 1908—19 in all. Of this number nine had eaten mussels before attack, at a time which might explain the illness. Dr. Haworth was informed that the mussels sold in Darwen during 1908 came from Sunderland Point Glasson Dock, Lancaster.

Dr. James Marsh, medical officer of health of Atherton, has forwarded to me a list of 15 cases of enteric fever which were notified in Atherton from October 23rd to December 20th, 1908, and all of whom had eaten mussels, generally raw. Dr. Marsh is unfortunately unable to supply the dates on which the shellfish were eaten, or the date of onset of the illness. He adds, however, that four of the streets in which cases occurred are in close proximity to Tyldesley, where the two principal purveyors of shellfish have their business. Most of the mussels eaten were purchased "at wakes" held in the same town.

The local mussel supply is obtained from Heysham Scaur in Morecambe, Glasson Dock, and Conway. Under all the circumstances, the precise source of these mussels must remain in doubt.

THE MORECAMBE MUSSEL INDUSTRY. (Map No. 32.)

The town of Morecambe is one of the chief, if not the chief, centres for the despatch of mussels on the west coast of England and Wales.

In the view of Messrs. Andrew Scott and Baxter there are many thousands of tons on the Morecambe beds at any one time, and there are, they report, more mussels on these beds than in all the other beds in the Lancashire and Western Sea Fisheries District. A large number of the mussels collected are despatched to Manchester and other large towns.

The annual average despatch of mussels from Morecambe amounts to nearly 2,000 tons, and there are, Messrs. Scott and Baxter state, over 100 men, or approximately one per cent. of the population of Morecambe, engaged in the mussel industry. At the time of my first visit to Morecambe in 1902 there were, about 54 boats engaged, and in former years there had sometimes been as many as 70. There were also many persons engaged in hand-picking the mussels.

The quantities of mussels landed at Morecambe, month by month, is well set out in the table furnished below, which is taken from the report of Dr. J. Travis Jenkins, Superintendent of the Lancashire and Western Sea Fisheries District, for the quarter ending December 31st, 1907.

Table showing weight in cwts. of Mussels landed from the Morecambe Mussel Beds during the Four Seasons commencing September, 1903, *and ending April,* 1907.

——	1903–04.	1904–05.	1905–06.	1906–07.	Mean of 4 years.
	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.
September	4,675	5,400	1,800	5,439	4,328½
October	6,300	13,000	8,250	9,527	9,269¼
November	5,400	7,612	10,500	8,365	7,969¼
December	3,500	5,580	9,850	7,542	6,618
January	3,250	3,000	6,446	8,509	5,301
February	3,950	3,500	6,120	6,237	4,951¾
March	3,200	2,925	4,609	4,864	3,899½
April	1,775	1,500	1,860	3,039	2,043½
	32,050	42,517	49,435	53,522	

The teaching of these returns is that the largest supplies of mussels are despatched as a rule in the months of October, November, December, January, February, and September, in the order named, and in no year has the quantity landed in September been relatively the largest. It is important to bear this fact in mind in view of the importance which has been attached to mussel influence in September upon the seasonal curve of enteric fever.

I am informed by Mr. Edward Gardner, Honorary Fishery Officer to the Lancashire and Western Sea Fisheries District, that in addition to the above figures, which represent the amounts sent away by rail, there are disposed of locally about 240 tons annually.

The mussels—a bag of which weighs about 1¼ cwts.—fetch from 1*s.* 6*d.* to 2*s.* per bag when the cost of carriage is defrayed.

I was able at Morecambe, by conference with some of the local fishermen, to obtain a very good general idea of the actual distribution of the mussels from Morecambe down to below Heysham Harbour to a point, that is to say, midway between Middleton Sands at a sandbank known as "Clark's Wharf." But since that date a careful survey of all the beds—or what are locally known as "skears"—in the district has been made by Messrs. Johnston and Baxter, with the assistance of Mr. Edward Gardner, of Morecambe, and a map of the survey thus made is contained in the report for 1905 on the Lancashire Sea Fisheries Laboratory at the University of Liverpool, from this I have derived much information and assistance in preparing the accompanying map (No. 32), which shows that the "skears" extend from the east of Morecambe westward to nearly opposite Heysham Harbour in the channel known as Grange Channel, and the main collecting area extends from opposite the Grosvenor Hotel past the northern end of "Clarks Wharf" and out into Grange Channel.

Some of these "skears" are never uncovered, while others are so only at low water of spring tides. The depth of water over some of the "skears" which are never uncovered ranges from 4 feet to 25 feet.

In order to collect the mussels the boats leave Morecambe on the ebb, each boat being furnished with an iron rake, fitted to a handle, varying from 12 feet to 40 feet in length, the actual head of the rake ranging from 15 inches to 3 feet in breadth, the length of the teeth being 6 inches to 12 inches.

When the condition of the flowing tide or the supply collected renders further fishing impracticable or unnecessary, the boats are sailed or rowed up to Morecambe, where they are met by carts.

The mussels are either placed directly into the carts or they are first washed in the adjacent water. I saw both procedures in operation. The selection of one course or the other appears to depend partly upon the time at the disposal of the fishermen, and partly as to whether the mussels have been gathered from "clean" or "dirty" ground.

A considerable quantity of the mussels are taken to the homes of the fishermen for cleansing and packing, but there is a very general practice, which appears to be a growing one, of depositing the mussels on the foreshore, often in dangerous positions, and there completing the cleansing and packing process.

The amount of the monetary return for the mussels seems to be somewhat a matter of chance. They are sold on what is known as "commission," and the result to the fisherman is, at times, somewhat depressing. For instance, a "bag," which contains about 1 cwt., or some 70 quarts, may realise anything up to 3*s.* 6*d.*

The cost of carriage averages about 1*s.* 4*d.* and the commission 4*d.*, so that when 1*s.* 8*d.* is deducted, there remains 1*s.* 10*d.* for the fisherman. Sometimes the fisherman receives nothing in return except the cost of carriage, which is, I am told, nearly always refunded.

There are about 50 boats engaged in mussel fishing in Morecambe, but the number varies considerably from year to year. There are also other boats fishing over the same ground from Heysham.

In addition to the boats there are at low spring tides several carts, the owners of which are engaged in the hand-picking of mussels over the "skears" which are there exposed. Sometimes the fishermen go out in boats over a "skear" which will be exposed at low water, and when the tide recedes the mussel gatherers proceed to hand-pick the mussels.

The debris from the riddling operations is brought back in carts to the beach, where it is deposited.

The Liability of the Morecambe Mussels to become Polluted by Sewage.

The sewage of Morecambe—almost exclusively a water-closet town—is, for the most part, discharged by means of the main outfall, which extends out to low tide level of spring tides at a point about half-a-mile westward of the West End Pier, where it empties itself into the Morecambe Channel between the "Old Skear" and "Seldom Seen Skear."

The treatment to which the sewage is subjected is by means of septic tanks alone, there being no bacterial beds, and the sewage as I saw it discharged on Friday, April 2nd, 1909, when in company with Mr. Lamb, the sanitary inspector, and Mr. Gardner, Honorary Fishery Officer to the Lancashire and Western Sea Fisheries Committee, was very far from satisfactory. What was being discharged was a thick black liquid, containing numerous small pieces of paper and some small fæcal masses, and the discolouration of the water thereby was to be seen for considerable distances around the outfall. It was just apparent that mussel skears, such as "Old Skear," "Seldom Seen Skear," and "Reap Skear," are in imminent danger of becoming polluted, while it was not improbable that on the first of the flood some of the sewage effluent might be taken up into the Ring Hole and at other times dangerously near to some of the "skears" to the north of this.

The "skears" to the west of the outfall are less liable to pollution by virtue of their greater distance from the outfall and the greater depth of water by which they are covered, but it appeared to me that, on the latter part of the ebb, some of these, too, in a small degree might be exposed to pollution.

The time selected for liberating the sewage is not the best calculated to reduce the risks which actually obtain. I was informed by the custodian at the sewage works that the effluent is liberated at the last three hours of the ebb and the first three hours of the flood, that is to say, when the dilution, to which the sewage is subjected—near the outfall—is lowest. Under these circumstances it is clear that the sewage, enormously diluted no doubt, is liable to be carried on the young flood into the Ring Hole or over the "skears" to the north thereof.

Apparently the best time to liberate the effluent would be as soon after the commencement of ebb as practicable, when, I am informed by Mr. Gardner, the current sets directly out into the bay. Under any circumstances the present method of liberating the sewage at low water should be rigorously avoided *

The above, however, is not the only source of pollution to which the Morecambe mussels are liable. There are still two sewers discharging into the Ring Hole between the Old Harbour and the East Pier, as well as the excreta of some 200 workmen in the Old Harbour itself. There are also, in addition, two sewers discharging eastward of the East Pier. Under the circumstances it is desirable to consider each of these in some detail from west to east.

The Old Harbour is now devoted to ship-breaking, and the workmen there use closets which discharge on to the foreshore below. This refuse, therefore, must, on the ebb tide, prove in some degree a dangerous source of pollution to the mussels in Ring Hole.

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* Since the above was written I have been informed that the tidal valve is now opened an hour after high water and closed about low water, and that arrangements are being made to open the valve as soon after high water as practicable and to close it an hour or so before low water, reopening it two hours after low water and closing it again when the tide reaches the tidal valve.

The Winter Garden Outfall takes the crude sewage from about eight houses, the Midland Hotel and station, as well as the Midland Laundry, which deals with the linen of all the Midland hotels. This sewer discharges into a culvert, which opens on to the foreshore and pours its contents into a channel which carries them to the Ring Hole.

The Green Street Outfall takes the sewage from about 36 houses and discharges at low water level near one of the pier jetties, which traverse the foreshore thereabouts. The sewage will, I understand, be much reduced in amount when another sewer, now under construction, is completed. Eastward of the pier there are two outfalls.

The Thornton Road Outfall drains about 35 houses and discharges into the Ring Hole, a short distance landward of the place where a large number of the mussels are culled over and cleansed prior to despatch to market.

The Bare Outfall takes the sewage from about 200 houses and discharges near low water mark. At the time of my visit this sewer was blocked up and broken in several places. Both these eastern outfalls discharge into waters which, on the ebb, must pass through the Ring Hole.

In addition to the above outfalls, there are also two sewers from Heysham which discharge in the positions shown on the map to the west of the Morecambe main sewer. One of these sewers—that nearest Morecambe West End Pier—drains a population of about 2,500, the other a population of 1,000.

Doubtless the sewage which enters the Ring Hole from the above sources soon undergoes great dilution, but in estimating the danger from these outfalls it has to be held in view that the mussel dredgers may be seen dredging up the mussels in the vicinity of such outfalls, and that mussel-washing also takes place thereabouts.

To sum up it is apparent that until all the sewers above referred to are diverted and cut off there is danger associated with the despatch to market of mussels gathered near the sewer outfalls in the Ring Hole as well as near to the Old Harbour.

It is an unfortunate circumstance that the Ring Hole is a favourable locality for the growth of mussels, and so much so is this the case that large quantities of mussels have been transplanted from the outside mussel "skear" into the Ring Hole, the fishermen having put themselves to much trouble in the matter.

In order that the risks to which the Morecambe mussels are undoubtedly exposed at present may be materially mitigated it would appear necessary:—

1. To divert all the sewage now entering the Ring Hole.

2. To liberate the effluent from the main outfall on the first of the ebb only, or at such times as a well devised system of float experiments may show to be desirable.

3. To prohibit the collection of mussels for human consumption from any "skears" in the vicinity of the existing outfalls.

4. To prohibit the laying down of mussels near any of the existing sewers, and to arrange matters in such fashion that under no circumstances should mussels be stored or washed in situations which would endanger their purity. I impressed upon the clerk, the medical officer of health, and surveyor the danger of existing practices, and since that date I have received communications from the surveyor as to what steps have been and are taken.

The surveyor, who comes from Southend, and who consequently possesses an intimate knowledge of the difficulties connected with the shellfish question, informed me, at the end of April, 1909, that the Health Committee had considered the matter, and had decided that:—

1. The septic tanks should be cleaned and the sewage treated upon the original lines. Two of the tanks were to be reserved for the treatment of the daily dry weather flow, and during storm tides the dry weather flow was to be passed through them in 24 hours. A similar volume was to be passed through the next two tanks, and after that amount the diluted sewage was to pass into the outfall sewer culvert, four times the dry weather flow being thus dealt with at the works. The tidal valve was to be opened as soon after high water as practicable, and in dry weather the valve to be closed 1½ hours before low water. But during storm it might be necessary to keep the valve open for a longer period to get rid of the storm water.

As regards the other outfalls the surveyor furnishes the following notes, and it is clear that each step will diminish the risks to which the shellfish were exposed at the time of my visit:—

West End.—It is intended to divert the sewage to the main outfall.

Bold Street.—Sewer to be connected to new sewer.

West Street and Alexandra Road.—To be connected with new system.

Winter Garden's Sewer.—A new sewer to be laid next winter to pick it up.

Ship Breaking Yard.—(?) Earth closet.

Green Street.—Intercepted by new sewer.

Thornton Road Outfall.—A new sewer to be laid.

Bare Outfall.—Will be dealt with at a later period.

THE ROOSEBECK MUSSEL BED. (Map No. 32.)

There is an important bed which extends along the Ulverston Channel at near low water level for a considerable distance (see map) reaching almost as far south-west as Foulney Island.

A good description of this bed has been written by Mr. Andrew Scott, of the Lancashire and Western Sea Fisheries Marine Laboratory at Piel Island,* and the conditions which now obtain are, I am informed, still practically the same.

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* Report on the Investigations carried on in 1895 in connection with the Lancashire Sea Fisheries Laboratory at University College, Liverpool, by Professor W. A. Herdman, D.Sc., F.R.S., and Mr. Andrew Scott, Fisheries Assistant.

This bed is, I understand, worked largely from Baycliff, seven to eight carts, with two persons per cart, visiting the bed. Sometimes mussel gatherers from other places in Morecambe Bay gather mussels from Roosebeck Scar, and on one occasion the mussels were transplanted to Cowp Scar to the south of Flookburgh.

Risks of Sewage Contamination.

The risks to which the mussels on Roosebeck Scar are liable are very small compared with those which threaten the beds at Piel Island, and those to which the Conishead Priory beds are exposed.

There are no sewers within a considerable distance of this bed, and it is not probable that the sewage coming down from Walney Channel on the ebb tide would be likely to be carried up the Ulverston Channel on the flood tide if, as I am informed, the young flood entering Morecambe Bay makes in the first place up the Walney Channel.

It will be noted, too, that the Ulverston outfall which threatens in so serious a fashion the Conishead bed is several miles distant from the Roosebeck Scar.

THE CONISHEAD PRIORY MUSSEL BEDS. (Map No. 32.)

The mussels on these beds extend for a short distance down channel from near Conishead Priory Station (see Map 32), but they are not, I am told by Mr. Andrew Scott and Mr. Eccles, much fished at the present time. Occasionally, however, some 20 men have been seen working on the beds.

Risks of Pollution by Sewage.

The main Ulverston outfall which discharges the sewage of some 10,000 people after passage through tanks, where it receives, Dr. Patterson, the medical officer of health, informs me, practically no treatment, enters the head of a narrow creek at South Ulverston in the position shown on the map, and at a short distance below this is another outfall which takes the waste products from the distillation of tar.

The topographical relation between these outfalls and the Priory mussel beds is such that the mussels therein cannot fail under some conditions to become polluted. There is also risk to these mussels from the drainage of some of the Bardsea houses.

THE PIEL ISLAND MUSSEL BEDS. (Map No. 32.)

There are in the vicinity of Piel Island and in the positions shown on Map No. 32 mussel beds on either side of Piel Channel, but Mr. Andrew Scott, of the Marine Laboratory, Piel, tells me that except in times of unemployment—such as occurred in the winter 1908-1909—but few mussels are collected hereabouts. I gather, too, from a report of the late Mr. Dawson that such mussels as are gathered are used largely for bait.

There can be no question that these beds are seriously exposed to the risks of contamination of sewage, and that under certain tidal conditions they may be contaminated by the crude sewage of a population of some 72,000 living in Barrow and Dalton, as the main sewer from this population discharges on to the foreshore on the position shown on the map.

The sewage thus discharged can be traced down the rivulet traversing the foreshore into the main channel, which passes over both the mussel beds here in question.

The foreshore in the neighbourhood of this outfall is much polluted, and paper, with other sewage debris, can be detected at long distances from the outfall. This is especially apparent, Mr. Scott tells me, in certain states of tide and wind.

THE SCARTH HOLE MUSSEL BED. (Map No. 32.)

This bed is situated immediately opposite the northern end of Walney Island, and occupies the foreshore at the spot known as Lowsy Point, as well as a certain portion of Scarth Bight. A large part of this bed is never ebb-dry, but the higher portions are visible at low water, more especially at spring tides, when some hand-picking may be done. The lower parts of the beds in Scarth Hole are always covered by several feet of water.

These beds are visited by mussel gatherers from Askam in the Duddon estuary, from Barrow, and from Baycliff in Morecambe Bay.

The number of persons engaged varies materially from time to time, scarcity of employment in Barrow leading to the visit of these beds by large numbers of persons. Sometimes, I am informed, as many as 40 persons may be at work there, but at other times not more than nine or ten persons frequent it.

The Risks of Contamination by Sewage.

The Walney Channel, which may be here regarded as extending the whole length of Walney Island, is some 10 miles long, and separates Walney Island from the mainland, and into one or another portion of this channel there is discharged for the most part untreated almost the whole of the sewage of Barrow-in-Furness and of Dalton, and it would appear that altogether into the channel itself the sewage of from 60,000 to 70,000 persons is thus discharged.

The tidal conditions in Walney Channel have an important bearing upon the risks to the Scarth Hole mussel beds.

On the flowing tide the channel fills partly from the north and partly from the south, the two tidal currents meeting at a spot known as "Walney Meetings," which is a little distance north of the town of Barrow and just south of Ormsgill (see map). It would thus appear that at the end of the flood tide there is an accumulation of sewage at or near Walney Meetings.

At this time there will be an enormous volume of practically pure sea water over the Scarth Hole mussel beds. When the tide turns, *i.e.*, on the beginning of the ebb, I am informed that for the first 2½ hours or thereabouts the tide from the whole of Walney Channel sweeps northwards, and, if this be so, the diluted sewage from all the outfalls passes over the Scarth Hole mussel beds. But at the end of this 2½ hours the tides split at "Walney Meetings," the southern water passing to the south, the northern to the north.

Now the only outfall in this northern section is one which takes the sewage from a population of some 3,000 people, and it is this volume of sewage which has more particularly to be considered in relation to the Scarth Hole mussel beds.

At quite low tide the volume of water in this part of Walney Channel is very small, but at Scarth Hole, at the north end of Walney Island, there is a considerable depth of water and width of channel even at quite low water of spring tides.

Having regard to all the facts, the risk of pollution cannot be altogether neglected, and it would be preferable to transplant the Scarth Hole mussels to some safer locality before despatching them to market for human consumption.

Epidemiological Evidence.

The only evidence which the medical officer of health of Barrow-in-Furness, with its population of about 58,000, is able to supply relative to enteric fever and mussels is as follows:—

Particulars of Cases of Typhoid Fever suspected to be caused by Shellfish.

Mr. S. R., 15, Highfield Road.—Reported typhoid. February 18th, 1908, gathered shellfish, viz., clams, at the north end of Walney Channel, near Scarth Hole, partook of some uncooked about a fortnight previous to being notified.

Mr. C.'s boy, 99, Hartington Street, and Mr. P.'s boy, 102, Holker Street.—Reported 28th December, 1908. Partook of some cockles and mussels boiled, which Mrs. C. purchased from one of the fishermen who come hawking. These shellfish were supposed to come from Baycliff or Bardsea, and they were consumed between a fortnight and three weeks previous to the date of notification.

Mr. M.'s children, 36, Parker Street (two young men).—Reported typhoid December 3rd, 1908, partook of clams boiled, which were gathered in Walney Channel, near Scarth Hole, about a month previous to notification.

Mr. A., Crow Nest Hotel.—Reported typhoid February 16th, 1909, partook of mussels raw, which were gathered in Walney Channel on Head Scar, situated near to the old pier at Roa Island.

Mr. T., 36, Latona Street.—Reported enteric on February 16th, 1909, partook of clams raw, which were gathered in Walney Channel, near Scarth Hole, about a fortnight previous to notification.

P.S.—The notification date was probably not less than a week after the first symptom or onset of the fever. In connection with these cases it will be useful to note that during the same period covered by their appearance there were 22 other reports of cases in which there was no history of shellfish being eaten.

THE MORECAMBE BAY COCKLE INDUSTRY.

(Map No. 32.)

The immense expanse of sand which is at low tide left uncovered in and around Morecambe Bay affords one of the finest natural habitats and collecting grounds for cockles in the British Isles; indeed, it, together with the Wash and the sands in Burry Inlet off the Gower Peninsular, are by far the most important cockle areas in England and Wales.

As regards Morecambe Bay, the accompanying map, which is on a scale of two miles to the inch, shows by green colouration the approximate distribution of the cockles over the several sands which ebb dry, and over one or other of these sands cockle-gatherers from places such as Baycliff, Bardsea, Ulverston, Cark, Flookburgh, Kent's Bank, Grange, Silverdale, Bolton-le-Sands, Hest Bank, and Morecambe pursue their calling.

The most important centre of all is Flookburgh, near Cark, and from Cark Station a special shellfish train starts each evening and connects at Carnforth with the main line trains, which take the cockles to many of the large towns in Lancashire and the Midlands—largely to Manchester and Leeds.

The importance of Cark Station as a centre for the diffusion of cockles may be gathered from a return compiled by Mr. W. R. Nash, of The Mount, Cark-in-Cartmel, and contained in the Cartmel and Lower Holker Almanac for 1909.

Number of tons of cockles and mussels sent away from Cark Station during the last 27 years:—

Year.	Tons.	Year.	Tons.
1882	2,827	1896	930
1883	2,665	1897	2,011
1884	1,177	1898	1,797
1885	861	1899	1,286
1886	662	1900	1,059
1887	1,040	1901	1,250
1888	1,616	1902	1,232
1889	2,488	1903	885
1890	3,161	1904	770
1891	2,749	1905	394
1892	1,684	1906	1,009
1893	1,336	1907	1,647
1894	1,218	1908	1,330
1895	743	1909 (10 months)	439

The year 1907 was considered the best year for cockles since 1898, and the year 1908 would it was thought equal 1907.

If the year be taken as from November in one year to October in the following year, both inclusive, there were 1,514 tons in the year ending October, 1907, and 1,636 tons in the year ended October, 1908, or an increase of 122 tons; but if the ten months of 1907, with 1,167 tons, be compared with the ten months of 1908, with 1,156 tons, there is a decrease in 1908 of 11 tons.

Although the figures furnished in the above table relate nominally both to mussels and cockles, they may be taken as applying almost solely to cockles, as Mr. Nash states that only 4 cwt. of mussels were despatched during 1908 and none during 1907. But in the five years 1900 to 1904 there was an average despatch of upwards of 200 tons.

The Seasonal Exportation of Cockles from Cark Railway Station.

The accompanying table, which is taken from the report for the quarter ending December 31st, 1907, of Dr. J. Travis Jenkins, Superintendent of the Lancashire and Western Sea Fisheries District, serves to show the quantities of cockles despatched month by month during the years 1905-1907 :—

—	1905.	1906.	1907.	Mean of Months.
	Cwts.	Cwts.	Cwts.	Cwts.
January	399	1,535	3,758	1,423
February	459	1,413	3,201	1,268¼
March	428	1,381	2,354	1,040
April	414	2,226	2,876	1,379
May	306	1,600	1,526	858
June	82	390	1,239	427¾
July	22	70	290	95½
August	76	374	1,239	422¼
September	532	1,213	2,725	1,117
October	1,374	2,976	4,290	2,160
November	1,816	3 908	5,846	2,893
December	1,128	3,031	4,235	2,098½
	7,036	20,117	33,579	

The above table is also instructive in the matter of the seasonal prevalence of the cockle supply. It will be noticed that during June, July, and August very few are sent away, although there is no statutory close season.

The Risks of Contamination to which the Morecambe Bay Cockles are exposed.

Generally speaking these are in my view but slight, and when it is borne in mind that the sandbanks upon which the cockles are situated are either islands or peninsulas and that Morecambe Bay is some twelve miles broad with no towns of first-class magnitude draining thereto, it will be seen that the danger is probably theoretical only.

But, this notwithstanding, there are obviously places where cockles may be collected, stored, or washed near to sewer outfalls which would seriously endanger the purity of the molluscs say for example at places such as Grange or near the Bare Outfall, south of Hest Bank. But obviously here, as elsewhere, regulations and restrictions should be imposed.

THE DUDDON SANDS MUSSEL BEDS. (Map No. 32.)

The mussels in the Duddon Channel (Map No. 32) are found mainly in deep water over the area coloured blue, and extending from about half-a-mile westward of Hodbarrow Point to the point marked Bullstone Bed. But in addition to these deep water mussels, which are even at low water of spring tides covered with several feet of water, there are certain " skears " which ebb dry, and which in some seasons yield plentiful supplies of these molluscs. One of these is known as "Mitchillear Scar," situated immediately to the south of Duddon Channel, and another which has reappeared within the last year is that known as "Hardacre Scar," which is coloured in blue to the north of Sandscale Haws.

The mussels on this scar are hand-picked, those in the channel are raked for in the usual fashion.

The mussels when collected are taken either to Haverigg, on the Cumberland side, or to Askam, on the Lancashire coast, and they are despatched by train either from Millom or Askam to Manchester and other large towns, as well as being to some extent sold locally.

These beds in the Duddon are also visited at intervals by persons from Baycliff in Morecambe Bay, who bring carts in which to take the mussels back to Baycliff.

Apparently the Duddon industry is not as flourishing as it was formerly, there being now, I understand, but few persons wholly engaged in mussel gathering. At the date of my visit two boats were at work, but there may be, I am told, sometimes nine or ten people from Haverigg.

Liability of Contamination.

The main risk to which the mussels in the channel are exposed is from the sewage of Millom and Haverigg, the combined population of which is about 12,600.

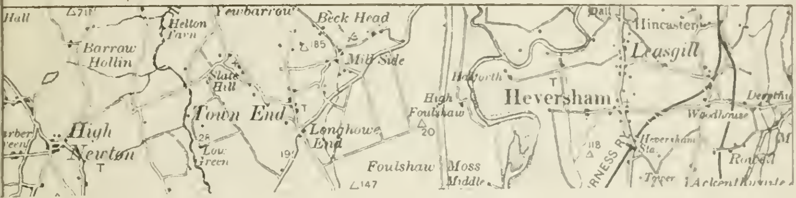
The sewage of Millom itself—mainly a water-closet town—is discharged untreated by means of three separate outfalls entering Borwick Harbour, which, after a short run, joins another channel, the waters of which eventually pass over the mussel beds, the nearest beds being about two miles distant from the outfalls which drain respectively populations of 1,800, 6,000, and 200.

The sewage of Haverigg, with a population of some 2,200, discharges by means of three separate outfalls in the position indicated by red crosses, and the stream into which they discharge contains at low tide very little water.

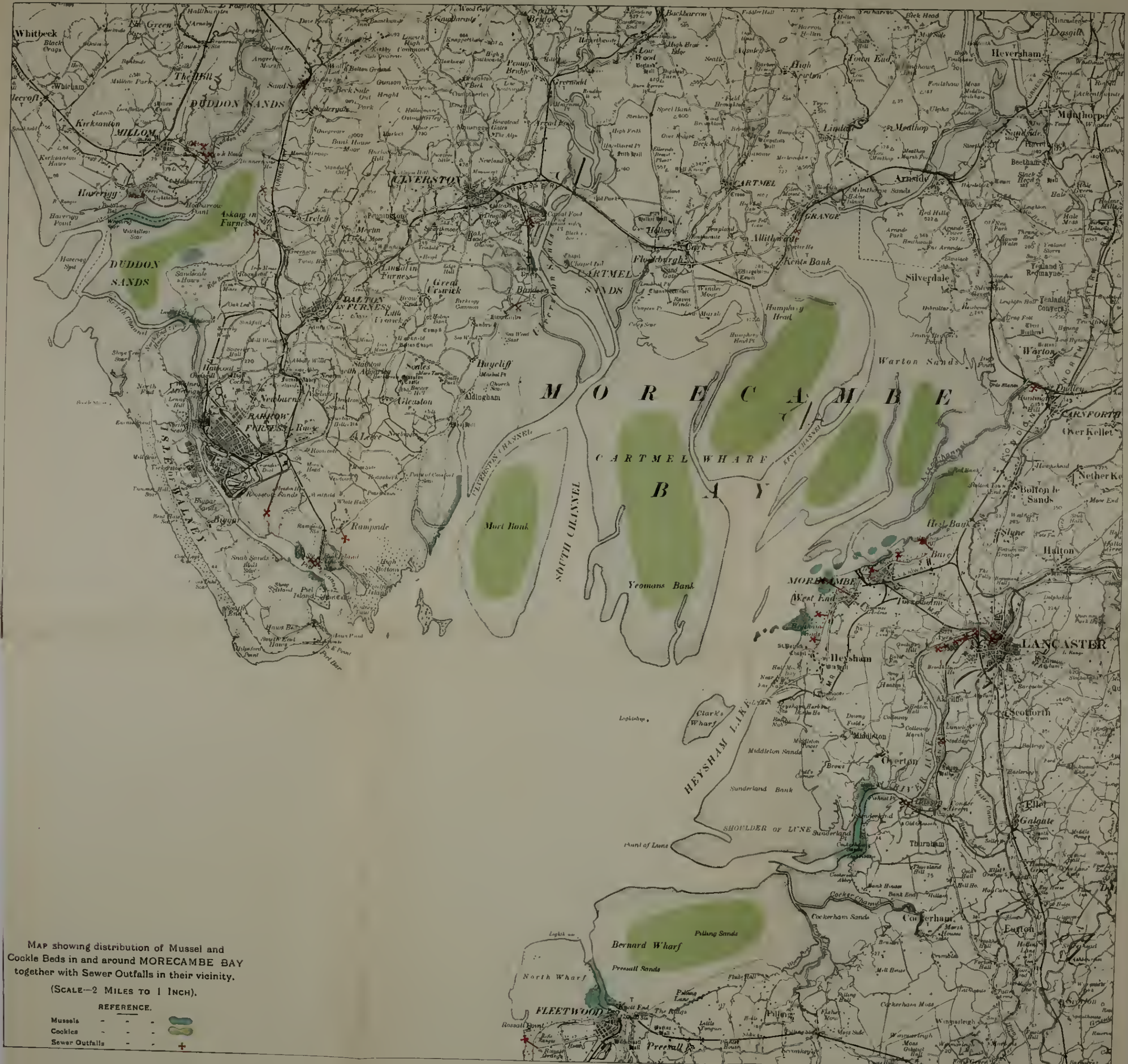
Clearly there is risk to the mussels in the channel both from the Millom and the Haverigg sewage, although the enormous dilution which the sewage undergoes in an estuary three to four miles in width must reduce the risk to very small proportions. But there is another risk to be considered, and that is the risk occasioned by washing the mussels collected in the channel in the Haverigg stream into which, as has been seen, three sewers empty. There was some divergence of evidence as to whether such washing occurs, but the facts placed before me by Mr. Harvey, the surveyor of Millom, as also the result of my own observations, leave little doubt that at any rate occasionally such washing does take place.

The risks to which the Duddon Channel mussels are subjected would be greatly reduced were such mussels transplanted to the scars which ebb dry, and were the practice—occasional only perhaps—of washing the mussels in Haverigg Creek entirely discontinued.

MAP No. 32.


Hall
Barrow Hollin
Helton Tarn
Yewbarrow
Beck Head
Mill Side
Slate Hill
Town End
High Newton
Low Green
Longhowe End
High Foulshaw
Foulshaw
Moss
Middle
Heversham
Hincaster
Leasgill
Woodhouse
Heversham Sta.
Rowell
Ackenthwaite
FURNESS RY
185
20
147
118

MAP No. 32.



MAP showing distribution of Mussel and Cockle Beds in and around MORECAMBE BAY together with Sewer Outfalls in their vicinity.

(SCALE—2 MILES TO 1 INCH).

REFERENCE.

Mussels - - - 🟦

Cockles - - - 🟩

Sewer Outfalls - - +

Ordnance Survey, Southampton, 1910.

THE COCKLE INDUSTRY OVER THE DUDDON SANDS.
(Map No. 32.)

Cockles are collected over large areas of the Duddon Sands and sent away by rail from Askam station to large towns. But few cockle gatherers go, I understand, from Millom or Haverigg.

Risks of Contamination.

Generally speaking, the risk to the cockles is not so great as that to the mussels, owing to the fact that the sewage tends to keep to the main channels in which mussels but not cockles are largely gathered. The risk to the cockles depends largely upon whether they are gathered near to the Askam or Haverigg sewer outfalls or to the little rivulets traversing the scars which carry away the drainage from these outfalls. The main Askam sewer drains a population of about 2,000, and it is subjected to some screening and sedimentation as well as passage through coke filters before it is discharged. Similar risk would, of course, attend the washing of the cockles near either of these outfalls or rivulets. The risk in the case of the Duddon Sands is not, I think, great.

As an illustration of the risks which already obtain and of the need for rigorous control, it may be mentioned that I myself saw on March 27th, 1909, six men collecting cockles over the patch of sand which extends between the Haverigg outfalls and the shore.

MUSSEL BEDS IN THE ESTUARY OF THE ESK (CUMBERLAND). (Map No. 33.)

At the date of this survey the only centre for the collection and despatch of mussels along the Cumberland coast was situated at the village of Ravenglass, near the mouth of the River Esk, where mussels are found in considerable quantity in the position shown in blue on Map No. 33.

Over this area, and more particularly over that portion of it near the mouth of the estuary, mussels are raked for with long rakes during the season and sent from Ravenglass station to Manchester, Whitehaven, Carlisle, and other towns. Raking commences about three hours after high water, and continues till the tide turns. The mussels, when gathered by the rakes, are deposited in the bottom of the boats, together with such debris as may at the same time have been collected. When the tide begins to rise the boats are brought up the Esk near to Ravenglass boathouse and the mussels thrown into the water a little above low tide level where they are allowed to remain until the next low tide, when they are separated, cleansed, and bagged for market, the smaller mussels being taken down channel in the boat and deposited in suitable situations in the estuary. No serious attempt at transplantation or mussel culture has as yet been made in the Esk.

Before mussel dredging can be undertaken it is necessary to obtain a licence from the owner of the beds, a merely nominal charge being made for each licence. Each boat carries two men, and it is possible to collect seven or eight bags per tide, from 3*s.* to 3*s.* 6*d.* being obtained for each bag of 1 cwt. Sometimes more than three boats are engaged, and six boats are occasionally at work.

Risks of Contamination.

The excrement disposal of the village of Ravenglass, with a population estimated by Dr. Cass, the medical officer of health of the Bootle Rural District, at about 200, is almost entirely carried out by means of privies, there being not more than half-a-dozen water closets in this village.

The slop water of the northern side of the village street is thrown casually on the foreshore, that of the southern side is led away by certain drains or sewers.

There are in all two separate house drains and four small sewers which for the most part discharge their slop water high up on the foreshore.

One of the house drains is from a house situated practically in the village itself, and this discharges into a small rivulet traversing the foreshore which, after running about 100 yards further, enters the channel at a spot not far distant from the place at which the mussels are deposited for preparation for market. The only slop-water outfall which discharges directly into the channel is that which empties itself immediately seaward of the railway bridge which crosses the river Mite.

The worst feature in connection with these Ravenglass mussel beds is the house drain already referred to since the house thereby drained contains a water-closet, and the stream into which the drain discharges empties into the main channel in such a position that on the early flood some diluted drainage might be carried up over the mussels deposited on the foreshore.

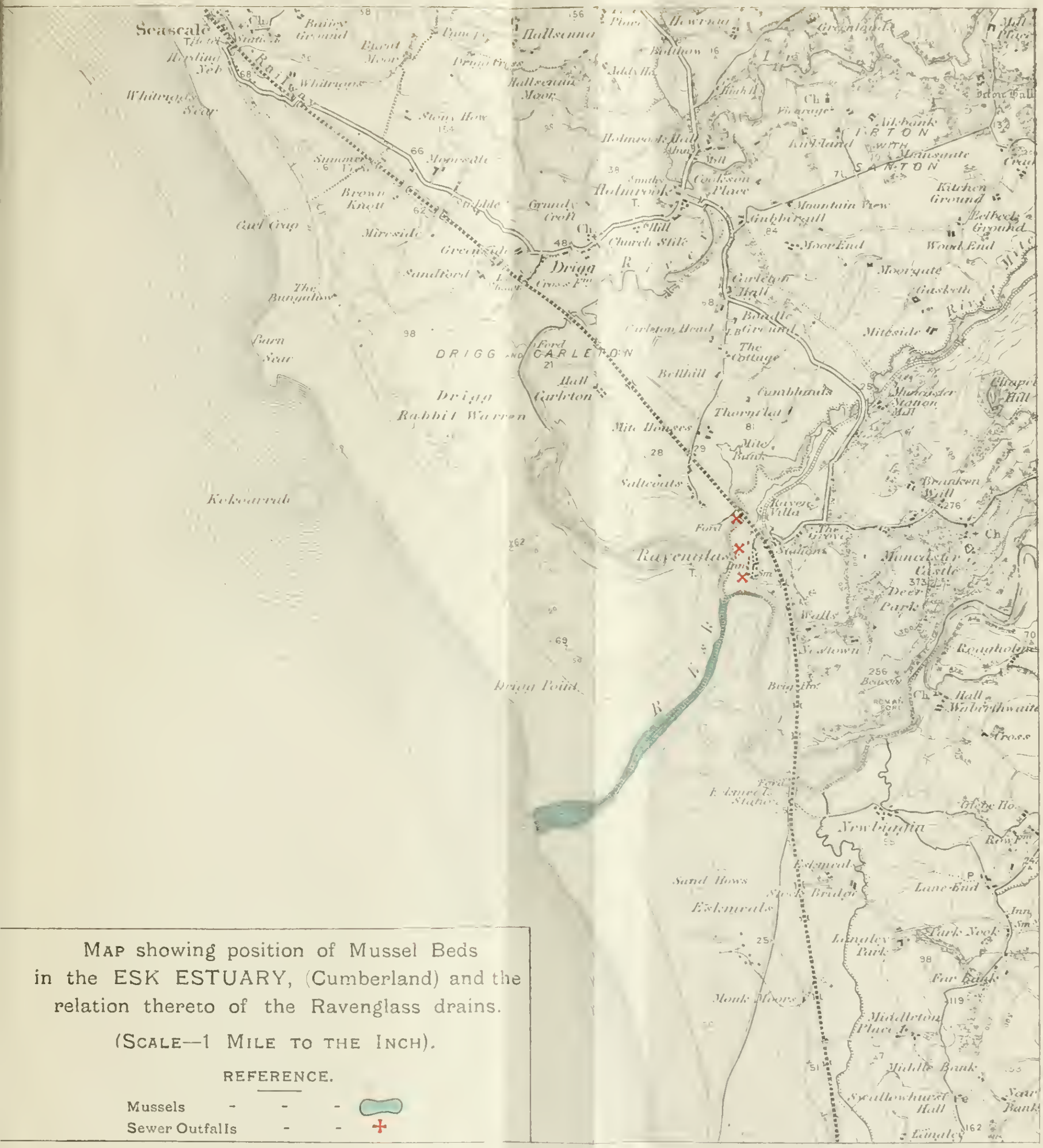
Either this drain should be cut off and the drainage of the house dealt with in a cesspool, or the cleansing of the mussels should be carried on elsewhere. In the meantime there would be dimunition of risk were the mussels deposited on the opposite side of the estuary, and Mr. Holmes, the Fishery Inspector of the Cumberland Sea Fisheries District, informs me that arrangements will be made for this to be done.

Apart from this, the risk of contamination, though present, is not great as the mussels even at low water of spring tides are covered with at least four feet of water. But in order to do away with such risks as obtain either all the slop water should be cut off or an intercepting sewer provided to carry the drainage out to sea.

Another alternative would be to transplant the channel mussels high up on the foreshore, and to retain them there for, say, 14 days prior to despatch to market. Mussels thus deposited in a carefully selected position might be regarded as practically free from contamination.

H. TIMBRELL BULSTRODE.

MAP No. 33.



Map showing position of Mussel Beds in the ESK ESTUARY, (Cumberland) and the relation thereto of the Ravenglass drains.

(Scale—1 Mile to the Inch).

REFERENCE.

Mussels - - - ⬭
Sewer Outfalls - - ✚

Ordnance Survey, Southampton, 1910.

APPENDIX I.

A Bill intituled "An Act for the Protection of Public Health against Dangers arising from the Consumption of Unwholesome Oysters."

Be it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows:—

Inspection of oyster layings, and prohibition of removal from insanitary layings.

1.—(1.) It shall be the duty of the council of every county and borough to ascertain from time to time the sanitary condition of the oyster layings, if any, within their county or borough, and for that purpose any officer of the council authorised by the council in that behalf may enter any such oyster laying and take therefrom samples of water for analysis.

(2.) Where any oyster laying is so situate with reference to an outfall of sewage as to cause serious risk of disease being communicated by the consumption of oysters taken from that laying, the council shall make an order prohibiting the removal for sale as human food of any oyster from the oyster laying, except after deposit for ten days in some other oyster laying approved by the council, and where any oyster is so deposited it shall not be removed from the oyster laying for sale as human food until after the expiration of those ten days.

(3.) The council shall, not less than ten days before making an order prohibiting removal of oysters from an oyster laying, serve, either personally or by post, on the person entitled to remove oysters from the oyster laying notice of the proposal to make the order, and shall give him an opportunity of being heard.

(4.) Notice of the order, when made, shall be served, either personally or by post, on the person entitled to remove the oysters, and if he is aggrieved thereby he may, within twenty-one days after service of the order upon him, appeal to the Local Government Board, and thereupon the Local Government Board may either confirm the order, with or without modifications, or rescind it, and if the order is modified it shall have effect as modified.

(5.) The order shall not come into operation until the expiration of the twenty-one days aforesaid, or, in case of appeal, until it has been confirmed by the Local Government Board.

(6.) The order shall, as soon as practicable after it comes into operation, be advertised by the council not less than three times in at least one local newspaper in general circulation in the district.

(7.) An order made by a council under this section may be rescinded by the council.

Penalties and procedure.

2.—(1.) If any person removes an oyster in contravention of the provisions of this Act or of any order under this Act, he shall be liable on conviction under the Summary Jurisdiction Acts to a fine not exceeding ten pounds, and in the case of a continuing offence to an additional fine not exceeding one pound for every day during which the offence continues, and to forfeit any oysters removed in contravention of the Act or order.

(2.) It shall be the duty of the council of every county and borough to enforce the provisions of this Act and of the orders under it with respect to any oyster laying within their county or borough, but, without prejudice to this duty, proceedings for any such contravention may be taken at the instance either of the council of the county or borough for which the order is made or of the council of any county, borough, or district in which any oysters removed in contravention of the order are sold or offered for sale.

(3.) In any proceedings under this Act it shall lie on the person charged to prove that an oyster is removed for any purpose other than sale as human food.

(4.) For the purposes of this Act a borough shall not be treated as forming part of a county, but a county or borough shall be treated as including any land covered with tidal water and abutting on the county or borough.

Power of Local Government Board to act in default of local authority.

3. If the Local Government Board are satisfied, on a complaint made to them, that a county or borough council have failed to make any order which it is their duty to make under this Act, the Board may, if they think fit, make the order, and thereupon the provisions of this Act as to the making of orders by a council (except those relating to appeal) shall apply with the substitution of the Board for the council, and any expenses incurred by the Board in connexion with the order may be recovered by the Board from the council as a debt due to the Crown.

Inquiries and expenses. 51 & 52 Vict. c. 41.

4. Sub-sections one and five of section eighty-seven of the Local Government Act, 1888, shall apply in the case of any local inquiry held by the Local Government Board for the purposes of this Act.

Definition of oyster laying.

5. For the purposes of this Act the expression "oyster laying" shall mean any pond, pit, ledge, float, or other place where oysters are kept until required for consumption, or are laid for propagation, growth, or fattening.

Importation of oysters.

6.—(1.) If it is made to appear to Her Majesty in Council that any oyster laying situate in any foreign country or British possession is so situate with reference to an outfall of sewage that there is serious risk of disease being communicated by the consumption of oysters taken from that oyster laying, it shall be lawful for Her Majesty in Council, by order, to prohibit the importation into the United Kingdom of oysters brought from that oyster laying, or from any specified part of that country or possession which includes that laying, except on such terms with respect to the temporary deposit of the oysters or otherwise as may appear to Her Majesty in Council expedient for the purpose of removing the risk of communicating disease.

(2.) Oysters imported in contravention of any order made under this section, shall be included amongst the goods enumerated and described in the schedule of prohibitions and restrictions contained in section forty-two of the Customs Consolidation Act, 1876.

39 & 40 Vict. c. 36.

7. This Act shall apply to Scotland, with the following modifications:— Application to Scotland.

(1.) The Local Government Board for Scotland shall be substituted for the Local Government Board:

(2.) The powers, duties, and liabilities conferred and imposed upon the councils of counties, boroughs, and districts shall be conferred and imposed upon the local authorities under the Public Health (Scotland) Act, 1897, and the districts of the local authorities under that Act shall, as the case may be, be substituted for counties, boroughs, or districts under the preceding sections of this Act, and shall respectively be treated as including any land covered with tidal water, ex adverso of those districts: 60 & 61 Vict. c. 38.

(3.) The expression oyster-laying, in addition to the meaning assigned to it in section five of this Act, shall include oyster bed and scalp:

(4.) Section eight of the Public Health (Scotland) Act, 1897, shall be substituted for subsections one and five of section eighty-seven of the Local Government Act, 1888.

8. This Act shall apply to Ireland, with the following modifications:— Application to Ireland.

(1.) The Local Government Board for Ireland shall be substituted for the Local Government Board:

(2.) Urban district shall be substituted for borough:

(3.) Subsections one and three of Article thirty-two of the Local Government (Application of Enactments) Order, 1898, shall be substituted for subsections one and five of section eighty-seven of the Local Government Act, 1888.

9. This Act may be cited as the Public Health (Oysters) Act, 1899, and shall come into operation on the first day of January next after the passing thereof. Short title and commencement.

APPENDIX II.

BLACKBURN CORPORATION ACT, 1908.

70. In case the medical officer of health is in possession of evidence that any person in the borough is suffering from infectious disease attributable to oysters or other shellfish brought from any particular oyster bed or place and sold within the borough, or that the consumption of oysters or other shellfish brought from any particuler oyster bed or place and sold within the borough is likely to cause infectious disease to any person residing in the borough, he shall report thereon to the Corporation, and the Corporation may thereupon give notice to the vendor to appear before them within such time, not less than twenty-four hours, as may be specified in the notice to show cause why an order should not be made requiring him not to sell oysters or other shellfish brought from the oyster bed or place or places mentioned in the notice until such order has been withdrawn by the Corporation, and if in the opinion of the Corporation he fails to show such cause, then the Corporation may make such order as aforesaid, and shall forthwith give notice of the facts to the Local Government Board.

An order made by the Corporation under this section shall be forthwith withdrawn on the Corporation or the medical officer of health, on their behalf, being satisfied that the cause of infection has been removed.

Any person selling any oysters or other shellfish within the borough in contravention of an order under this section shall be liable to a penalty not exceeding five pounds. Provided that no vendor of oysters or other shellfish shall be liable to an action for breach of contract if the breach be due to an order of the Corporation under this section.

Offences under this section may be prosecuted and penalties may be recovered by the Corporation before a petty sessional court having jurisdiction in the place where the oyster bed is situate, or the offence is committed, and not otherwise.

71. A person on whom an order has been made under the last preceding section of this Act may appeal against such order or against the refusal of the Corporation to withdraw such order either to a petty sessional court having jurisdiction within the borough, or, at his option, to the Local Government Board, who shall appoint an officer to hear such appeal. Such officer shall fix a time and place of hearing within the borough and give notice thereof to the person on whom such order was made and the town clerk not less than forty-eight hours before the hearing. Such officer shall, for the purposes of the appeal, have all the powers of an inspector of the Local Government Board under section 296 of the Public Health Act, 1875.

The Local Government Board may at any stage require payment to them by the person on whom such order was made of such sum as they deem right to secure the payment of any costs incurred by the said Board in the matter of the appeal.

The court or the Local Government Board, as the case may be, may confirm, vary, or withdraw the order which is the subject of the appeal, and may direct to and by whom the costs of the appeal (including any sum paid or payable to the Local Government Board as aforesaid) are to be paid, but pending the decision of the appeal the order shall remain in force unless previously withdrawn by the Corporation.

If an order is made without due cause, or if the Corporation unreasonably refuse to withdraw the order, the person on whom such order was made shall, if not himself in default, be entitled to recover from the Corporation full compensation for any damage which he has sustained by reason of the making of the order or of the refusal of the Corporation to withdraw the order.

The court or the Local Government Board may determine and state whether an order, the subject of appeal, has been made without due cause, and whether the Corporation have unreasonably refused to withdraw the order, and whether the person on whom such order was made has been in default.

Any dispute as to the fact whether the order has been made or maintained without due cause, or as to the fact of default where any such fact has not been determined by the court or Local Government Board, or as to the fact of damage, or as to the amount of compensation, shall be determined in the manner provided by section 308 of the Public Health Act, 1875, and that section shall accordingly apply and have effect as if the same were herein re-enacted and its terms made applicable to any such dispute as aforesaid.

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